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## C. NATO AWACS

### 1. INTRODUCTION

#### A. Background

NATO's \$1.8 billion program for the joint acquisition of a fleet of 18 Boeing E-3A Airborne Warning and Control System (AWACS) aircraft was finally settled with the signing of an MOU by a reduced consortium of 12 of NATO's 15 member states at the December, 1978, meeting of the Defense Planning Committee. This was by far the largest acquisition ever made by the organization itself. Meanwhile, over the preceding three and a half years of tortuous horse-trading, the customer had undergone several transformations, and along with these the proposed industrial team, while the system originally offered was enhanced, and the USAF and NATO programs were merged.

The Air Force officials of many countries consider this program to be potentially the most significant single improvement to overall allied capabilities in the history of the organization. NATO's airborne early warning (AEW) requirement was a direct result of the deployment of the latest generation of Soviet strike aircraft, capable of performing attack missions at altitudes below the coverage provided by the ground-based radars of the NATO Air Defense Ground Environment (NADGE) chain.

The principal argument has not been over the military need for the system, what held it up was the difficulty of arriving at mutually acceptable cost and

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work sharing arrangements for the procurement of a limited quantity of this very expensive existing system.

The E-3A provides a highly mobile, survivable surveillance, command, control and communications (C<sup>3</sup>) platform. The E-3A aircraft is a modified Boeing 707-320B powered by four Pratt & Whitney TF33 turbofans. The aircraft is topped by a Westinghouse rotating surveillance radar antenna housed in a "mushroom" shaped radome atop the fuselage. A "core" complement of on-board equipment (provided by Westinghouse, IBM, Hughes, Hazeltine, Eaton, Northrop, Collins and other firms) processes air situation data for guidance of tactical fighters. Improved Hawk missile battery control centers, as well as other Army air defense systems receive this same data from the AWACS via the AEGIS ground stations. The Boeing Aerospace Company (BAC) is prime contractor responsible for integrating the above into one of the most sophisticated weapon systems in U.S. and NATO inventories. This system will also give NATO headquarters a 250-mile look into Warsaw Pack territory and an extra 15 minutes' warning of an attack by air.

#### B. The USAF Program

The USAF AWACS program was initiated back in 1962, with the development decision coming in November 1967. At this time AWACS' primary mission was U.S. continental air defense. The AWACS contract definition phase was initiated in December 1968, with Boeing being awarded the prime contract, over competitor McDonnell Douglas in July 1970. The contract involved the development and testing of two competing E-3A radar designs; one developed by

the Hughes Aircraft Company, and the other by the Westinghouse Electric Corporation. Flight tests on both systems were conducted in 1972, and the Westinghouse radar was selected for the E-3A program by Boeing, with the concurrence of the U.S. Air Force.

In December 1974, the Defense Systems Acquisition Review Council (DSARC) approved initial AWACS production for the USAF. The first of 34 E-3A aircraft were delivered to the U.S. Air Force in early 1977, with the last USAF E-3A delivery taking place in mid-1984. In the meantime a major improvement program to upgrade the USAF fleet to the E-3B and E-3C configurations had gotten underway.

## 2. A SEVEN YEAR SALES EFFORT

### A. A NATO Program Emerges

Between 1970 and early 1975 there had been three main working groups within NATO evaluating possible Airborne Early Warning (AEW) requirements and solutions. The first of these, Subgroup #1 of the recently formed Tri-Service Group on Air Defense (a group subordinate to CNAD)<sup>1</sup> was set up in 1970 when it was realized that the new NADGE chain would not be effective in detecting and tracking the latest generation of enemy aircraft flying at high speeds and at very low levels. This group recommended the introduction of a mix of ground-based, specialized low-level surveillance radars, and AEW aircraft. These recommendations were approved 'in principle' by all members of the alliance, and the U.S. and FRG armies rapidly implemented the ground-based segment.

As for the AEW role, the NATO Air Force Armament Group (NAFAG, another subordinate group of CNAD) then set up at the initiative of the USAF, a Subgroup in October 1972 to explore the problem of detecting low-flying aircraft, to look at actual and potential hardware, and to examine the possibilities of collaborative NATO procurement. Elevated platform options explored included utilization of towers, booms, drones, and aircraft. Within several months the contending concepts had been reduced to one, aircraft. The aircraft examined included the USN/Grumman E-2C Hawkeye, Hawker Siddeley's proposed AEW version of the British Nimrod ASW aircraft, and the USAF/Boeing E-3A AWACS.

As with its service and tri-service counter parts, the NAFAG and its subgroups are purely governmental bodies, i.e., no industry representation, or participation is allowed.

Boeing at this time was only meeting periodically with the DDR&E's Tactical Warfare section, being kept up to date on any progress in Brussels, and assessing ways in which Boeing could support the USAF. Boeing was also meeting with the USAF representative on the NAFAG Subgroup, a Lt. Col. Walt Walker of the Air Staff.

In January 1973 the USAF decided to send or 'brassboard' AWACS over to Europe. One of two 'brassboard' AWACS Phase 1 development aircraft was flown over to Central Europe in April 1973 for demonstration and test purposes. Boeing helped the USAF plan the demonstration, e.g. where would the aircraft be based, what flight profiles would be flown, and what could and could not be demonstrated. The demonstration was startlingly impressive, and on one sortie over Central Germany an AWACS aircraft successfully detected every aircraft airborne between Paris and Warsaw. Officers from most of the NATO Air Forces were present to observe, with some actually flying on the aircraft. What the prototype did not have, however, apart from the full avionics suite scheduled for development, was an over-sea capability required for surveillance of the Greenland-Iceland-UK stretch in the North Atlantic, and the North, Norwegian and Mediterranean seas.

This revived the hopes of Grumman for their E-2C, for which they began development of an AN/APS-125 Advanced Radar Processing System to give the E-2C

an overland capability. The Hawker Siddeley/Marconi AEW Nimrod studies also picked up momentum despite the mere trickle of funds that they had been receiving from the British government.

In July, Mr. Foster of DDR&E invited the MOD's of NATO's three medium powers, the UK, the FRG and France to send technical experts to Seattle. The three sent teams over in October for several weeks of familiarization with the aircraft at Boeing and one flight aboard one of the two 'brassboard' aircraft.

By the fall of 1973 Lt. Col. Walker's replacement on the NAFAG Subgroup was beginning to be phased in, Lt. Col. Larimar.

The next group established by NATO, the AEW Special Task Group, had been set up in January 1974, which was to handle the hardcore procurement issues of source selection and definition of the ultimate configuration. The result of the comparative evaluation was a recommendation that the E-3A offered the best operational performance.

The UK continued funding for initial development of AEW Nimrod only as a backup to meet its national requirement, in case NATO should fail to agree in time on AWACS, while Grumman E-2C Hawkeye was removed from the picture once and for all.<sup>2</sup>

Note that, among these three choices the two that were either in production or a late stage of development were both from the same nation, greatly facilitating the selection of one of them over the other. Instead of the

usual situation of national governments and their armed forces championing their own contractors systems, in this case the Pentagon would be able to arbitrate and tell the losing firm and its governmental supporters to back off.<sup>2</sup>

At the time of the first meeting of the AEW Special Task Group at SHAPE in Mons, Belgium in January 1974, Col. Larimar invited Boeing to provide technical support. Boeing participation was to continue in all subsequent meetings (except for several early ones where the E-2C and AEW Nimrod were still involved). This marked a major departure as contractors could not have participated in the NAFAG Subgroup meetings, all of which took place in Brussels.

The Special Task Group (STG) was chaired by USAF Col. Robert Lilly. The STG set up two subsidiary groups: Working Group 1 chaired by a British MOD civilian named Jeffrey Stone which handled such programmatic issues as cost, schedule and industrial collaboration; and Working Group 2 which dealt with technical issues and was chaired by a German, Major Wolfgang Schmidt. These 2 groups met separately and jointly through 1974 and into the spring of 1975, shifting their location from meeting-to-meeting from one capital to another. Most meetings took place in the three medium powers' capitals, Bonn, London and Paris, as well as at the SHAPE Technical Center in The Hague, but there were also meetings in Copenhagen, Rome and Munich.

Once unanimous agreement had been reached on the USAF/Boeing E-3A, Boeing's John Schmick was in on all meetings, helping match up the system and the

requirement, helping write up terms of reference and generally supporting the two groups on technical and programmatic issues. Schmick operated primarily as a one man team practically living with the STG and its Working Groups, while also, bringing in ad hoc support from Seattle as needed occasionally.

Intermittently Schmick also met with the principal national governments in their respective capitals on a one on one basis. Shortly after selection, Boeing was asked for the first time in the spring of 1974, what could be done in the area of industrial collaboration.

As the program took shape, Boeing's support requirements picked up during 1974 and into 1975, it finally became necessary to set up a Brussels office.

Once source selection had taken place in the spring of 1974, the AEW Special Task Group began to study a series of E-3A configurations that could meet European requirements. These ranged from a "bare bones" version mounting only the radar and a communication system to transmit data into the NADGE system, through the basic USAF "core" configuration, to a more sophisticated version with enhancements to cope with the complex European combat environment. The provisional configuration arrived at was presented to the U.S. Defense Department for cost estimation, based on NATO force sizes ranging from 12 to 36 aircraft.

In March 1975 Boeing and the DOD responded to the first NATO Request for Proposal (RFP) on AWACS with an offer based on a 36 aircraft buy of the USAF core version, but one capable of accommodating as options various enhancements

recommended by the responsible NATO working group, the AEW Special Task Group. Cost estimates for various force sizes were also included. For a NATO buy of 36 E-3A in 1975, total program price would have been between 1.7 billion (\$48 million per aircraft) and 1.9 billion (or \$53 million per aircraft), depending on the configuration.

The following month, April, prior to a meeting of CNAD, Boeing and the USAF brought over a slightly modified System Integration Demonstration (SID) AWACS prototype to Europe to further convince the National Armaments Directors, national air staffs, and NATO staff officers of the system's capabilities. This second European demonstration was even more successful than the first. The modifications included the necessary enhancements for European operation in the SID AWACS prototype: an addition to the radar to provide the necessary pulse compression for over-sea surveillance; as well as a prototype Time Division Multiple Access (TDMA) secure data link terminal.

The CNAD meeting in April recommended that a full-time "NATO AEW Program Office (NAPO) (Provisional)" be immediately set up, on the assumption that the May 23 NATO Ministerial Meeting would retrospectively approve the decision. NAPO was to continue to coexist with a separate higher level policy group until the two would be merged into an NPL0 once the MOU officially launching the program was signed.

The NATO AEW Program Office (NAPO) was set up in Brussels, Belgium, on May 12, 1975, with prefinancing provided by Canada, France, the FRG, the UK and the U.S. The full-time personnel numbering 25 at that time, were all loaned from

the above five nations. A considerable amount of assistance was also provided by external national and NATO agencies, such as the SHAPE Technical Center. The first NAPO Director was the former NAFAG Subgroup chairman, Air Commodore D. Scrimgeour of the RAF, with USAF Col. R. Eaglet as his deputy. The objective of the Program Office was to provide NATO with an impartial in depth examination of derivatives or modifications of the E-3A AWACS for possible European procurement. To assist NAPO in this effort, the USAF let two contracts on behalf of NAPO, on July 1, 1975: \$2.5 million was awarded to Boeing for a contract definition study on technical feasibility, and industrial collaboration; and \$0.5 million was awarded to Eutronics\* (previously NADGECO) for a study of AWACS integration into NADGE, and other command and control networks.

By the spring of 1975 NAPO was set up, the STG had completed its work and dissolved and a fourth NATO subsidiary grouping was established by CNAD. Although the participating national representatives and technicians had no great difficulty recognizing the need by this time, there was still considerable scepticism and reluctance to acknowledge the requirement. The primary reasons for these problems was simply the undeniable fact that the size of the project meant it was competing for scarce resources, i.e. funding.

Meanwhile, at the May 23 meeting of the North Atlantic Council, the NATO nations had balked at the March 1975 proposal of Boeing and the DOD, largely due to its AWACS Special Task Group's evaluation that it included insufficient enhancements to meet military requirements for the European environment within an acceptable cost. In the meantime, Boeing proceeded with its initial Source

Selection Survey of European industry. The DPC met in December 1975 and approved the buy 'in principle' pending costs determination and the negotiation of offsets, and declared that a decision as to whether to buy the aircraft was to be made the following May. These negotiations were to take place within a new NATO grouping, the High Level Group for AEW&C, but the date slipped.

In June 1976, Boeing and the U.S. DOD came up with a revised proposal along the lines of an earlier NAPO request, that was designated the AWACS Model B. When Boeing started to develop the Model B proposal for NATO, the goal had been to offset about 25% of the cost of the program through a work-sharing scheme, while holding the price within what was considered an acceptable range, 10% of the off-the-shelf price. But Boeing found that this industrial collaboration (IC) plus the requested enhancements could not be introduced without substantially exceeding the 10% barrier. The Model B cost estimate came to a startling \$3.1 billion. The customer considered the penalty for industrial collaboration to be far too high.<sup>3</sup> NAPO therefore requested that a more 'realistic' offer be provided by the end of October 1976 so as to allow enough time for an evaluation prior to NAPO making recommendations to be presented at the DPC meeting in December.

Guidelines for this proposal, designated Model C, were that it was to incorporate as many Model B features as possible, but the total program cost was to be considerably lowered.

First of all, only the larger contributing nations would now qualify for work sharing. In addition to the U.S., candidate industries were now reduced to Canada, France, the FRG, and the UK. Then began the first of the series of concessions on the U.S. side, as the DoD and USAF moved into a selling mode. One of the first cost reductions for NATO was achieved by a USAF decision to incorporate a number of the Model C enhancements into its own AWACS aircraft, and thus

providing greater commonality. The USAF agreed to pay all the R&D costs for these common enhancements. The greatest cost reductions were achieved, however, by reducing the number of aircraft down to 27 from 36.

The cost to NATO of acquiring 27 Model C AWACS, to cover up to eight operational patrol areas around the clock, was estimated at \$2.36 billion. This included an estimated penalty of \$160 million for Industrial Collaboration due to the necessity of setting up and qualifying second sources and opening new component production lines for relatively short runs in Europe and Canada.

A NATO decision was awaited in December 1976, but again the ministers put off a procurement decision until the following spring. This revived immediate activity in Britain to uprate the option of converting the Nimrod from an ASW to an AEW aircraft. Confidence that NATO would ever buy the E-3A began to slip.

## B. The Selection of a Common Funding Approach

Several solutions to the problem of financing a NATO AWACS force were studied by NAPO. These included:

- (1) The possibility of several nations each buying a number of the aircraft and then dedicating them to NATO;
- (2) The possibility of payment being made via the existing NATO Infrastructure Program's funding procedures with each nation virtually obliged to contribute if it wishes to draw on the fund for other purposes (as is the normal external off-setting of one program against another within the total Infrastructure Program);
- (3) The possibility of a special voluntary fund being set up along Infrastructure lines, with firms from the funding countries participating in the production of the system.

The last of these possibilities was the one in which the most interest was shown. Similar to the previous generation NADGE system, special funding/work sharing arrangements would have to be reached, except this time NATO would retain ownership and the project would move outside of the NATO Infrastructure Program all together, wherein all such joint C<sup>3</sup>/Early Warning projects had heretofore fallen. Though still an alliance wide project, it would thereby begin to resemble more of an ad hoc interallied weapon system project.

As of mid-1975 NAPO was disturbed at the number of countries still indicating a preference to contribute only to the operating costs of a NATO AWACS force (through NATO's Military Budget). At that time the U.S. expressed its willingness to contribute around 25% of its share of the conventional Infrastructure funding. This percentage was set by the Senate Armed Services Committee as a maximum USAF AWACS allocation to NATO, one which corresponded to 9 aircraft of the then proposed NATO force of 36 aircraft.

### C. The Germans Hold back and the British Withdraw

In the meantime, at the level of the individual European governments, each was reviewing its multi-year budget, matching the capability of the AWACS to enhance the effectiveness of their forces to the need to cut out or postpone individual programs from the various budgets. For the prospective major funding nations adequate offset, as well, was also a major issue (i.e., Canada, France, the FRG, and the UK).

German hesitations were particularly critical in this respect. The Bundestag had tied their considerable share of the funding not only to industrial collaboration (i.e., an internal offset), but to a number of external offsets that included U.S. selection of the Leopard II, and later as an alternative, the 120 mm tank gun and the Gepard anti-aircraft armored vehicle. This created very sticky problems.

For the British, who had been the most strongly committed of European proponents of the system, the situation was becoming critical by the beginning

of 1977. The time it was taking for a consensus to be built through the necessary political, budgetary and industrial adjustments within and between the NATO member states was forcing the UK to make a difficult decision. The British Defense Minister, Mr. Fred Mulley was well aware that it was both cheaper and more effective to take a share in the NATO AWACS buy. However, the jobs and funding committed to its own national backup airborne early-warning alternative was reaching the point where it could no longer hedge its bets. Either it would have to fully commit itself to the Nimrod program, or channel its resources toward a participation in AWACS. In addition the defense minister was coming increasingly under fire from his unions and industry to buy British. Consequently, he set March 25, 1977 as his deadline for the rest of the Alliance to commit itself to an AWACS buy. Otherwise Britain would have to go it alone, and contribute in kind to the integrated NATO AEW system as it did with its predecessor, NADGE, with the UKADGE. The deadline came and passed. Britain was out of the AWACS buy.

NATO then began to develop a new AWACS procurement program. With the 11 Nimrods, the prospective NATO purchase of AWACS dropped by a third to 18 aircraft, the 11 Nimrods replacing 9 AWACS in its northern maritime surveillance responsibilities. Consequently, whereas the British had been going to contribute only 20% in cash to a common buy it was now contributing in kind for 33%. This naturally enough satisfied British industry and labor at having gained a larger amount of work, while reducing disproportionately the total initial cost of procurement to the other participants. Boeing's industrial collaboration proposal, as well, had to be once again adjusted, one which in any case was structured for maximum flexibility vis-a-vis national

participation. The plan up till that time had been for British industry to provide for Installation and Check-out, i.e., the final assembly line for the NATO E-3A's.

#### D. Merger of USAF and NATO Programs

The NATO Program, having readjusted to the British withdrawal, took another step forward at the December 1977 meeting of the DPC. At this time it was announced that agreement had been reached in principle for a merger of the U.S. and NATO AWACS programs. After this meeting, an initial funding of about 5 million was expected to be provided by the member nations for research, development, and procurement of long-lead items.

According to John B. Walsh, NATO Deputy Secretary General for Defense Support, the decision to develop a common version of the E-3A for both the USAF and NATO would reduce the cost of the program to a point where it was likely the necessary funding commitments could be obtained from member nations over the following six months.

The idea of a merger evolved from NATO staff studies, but was formally proposed by the U.S. Under the merged development program, a common management office was to be established with the U.S. dropping its independent development of Block 2 and 3 AWACS aircraft in favor of one development program for the standardized aircraft.

Due to uncertainty over funding, NATO staff had to propose two versions of the NATO AWACS program to the DPC. One involved NATO purchase of 18 E-3A aircraft

without some of the intended mission avionics systems, and the other was for a purchase of 16 aircraft with the complete system.

The new approach also was designed to handle the other end of the NATO equipment spectrum through interoperability, i.e., the problem of destandardization caused by the British opting to go it alone. This seemingly inevitable aspect of all NATO-wide programs meant that not only would there need to be interoperability between the E-3A and the NADGE, UKADGE, and certain sea-borne components, but now between all these elements and the British Nimrod AEW aircraft. The U.S. Navy's Grumman E-2C aircraft, were to be able to interface, as well, with the sea-borne portions of the system and with the aircraft, but not with the ground-based system.

#### E. The Governments Agree Upon a Payment Schedule

Over the previous year a revised schedule of payments had to be worked out by Subgroup 3 on Contracts and Finance, of the NATO group created to deal with the negotiations for the multilateral MOU, the High Level Group (HLG) on Airborne Early Warning and Control. The revised schedule called on some nations to make the greater share of their payments earlier in the program, so as to permit others to make their payments later.

HLG subgroup 3 on Contracts and Finance issued a series of Working Papers in this regard. Assuming that agreement would be reached on a formula for sharing the acquisition costs for the NATO AEW system, HLG Subgroup 3 worked

out procedures that would solve three specific problems regarding the financial arrangements to be implemented.

- (1) What procedures will be followed in adjusting for inflationary impacts, particularly in regard to the payment phasing concept where some nations make their payments in advance of the pro-rata requirements and other nations payments lag?
- (2) Within this payment phasing concept, how will adjustments for annual funding requirements, exclusive of inflation, be accommodated?
- (3) What procedures will be followed in regard to selection of currencies and exchange rates to be used for national payments and where, if necessary, will currency exchange transactions be performed?<sup>4</sup>

Subgroup 3 therefore came up with a procedure that

would deviate from some of the suggested criteria and follow more closely the procedures which have been agreed for use in the multinational F-16 programme. A significant difference between the F-16 and the prospective NATO AEW program's is that in the former, all participating nations plan to make their financial contributions according to their pro-rata shares at the same time. In this arrangement, effects of inflation, annual cost variations, and currency exchange transactions are shared in real time, with no necessity to transfer these effects to later years for nations who would prefer to defer their payments.<sup>5</sup>

#### F. Closing in on the Agreement

At the DPC meeting in late May 1978, the program was reviewed but again no decision was reached. The Defense Ministers did agree though, to continue to

push for review and approval throughout the national level, while setting the next meeting in December for a full go-ahead for the program.

At the same time the committee also agreed to continue the funding of predevelopment activities.

The program still contained options for French participation at this time. On the governmental/funding side it was expected that this would be through a leasing arrangement with NATO rather than a direct participation in the purchase of the system. But on the industrial collaboration side the possibility of re-engining the NATO E-3A's with the French-built Snecma/General Electric CFM-56 engine could be retained only until October 2 of that year. After that date introduction of the alternate engine would no longer be possible without a slide in the scheduled first delivery to NATO in 1982.

An additional minor hitch occurred in the program in June, 1978 when only Luxembourg, the Netherlands, Norway, Portugal, Turkey, the UK, and the U.S. signed a statement of understanding to authorize funding through September. As of the beginning of August, Belgium, Canada, Denmark, the FRG, Greece, and Italy had still not signed the statement of understanding.

On October 2, the deadline for re-engining the E-3A with CFM 56 engines came and passed without a French decision on participation.

In the fall the U.S. and FRG defense ministers were able to hammer out an agreement covering German participation in the program, and eliminating what had all along been the program's single greatest obstacle. The Germans were finally satisfied with the DOD's package of internal and external offset work. In late November the Bundestag's budget committee overwhelmingly approved German Participation in the NATO acquisition of the 18 E-3A, by a vote of 24 to 8 (with one abstention), authorizing the FRG to assume 28% of the \$1.8 billion cost. Several days earlier the Bundestag's defense committee had approved German participation by a vote of 24 to 3 setting the limit of participation at 30.7%.

In approving the AWACS program, the defense committee added a series of provisos to the final German legislation that slightly stiffened German demands for increased offsets in undertaking its share of the program.

The defense committee called on the U.S. to drop the remaining charges for research and development recoupment, administrative costs and a personnel charge that the Germans had been assessed originally.

Language was also included that stressed that the principle of joint financing should be accepted and that NATO would split the cost of maintaining the NATO E-3A Component's Main Operating Base at Geilenkirchen (near Aachen in the FRG). In addition the committee attached a proviso that said German industry must have proper participation in the maintenance and repair of the system when it is operational.

The Bundestag approval allowed German Defense Minister, Hans Apel to formally announce at the DPC meeting the following week the FRG's assumption of its share of the program's funding. Other NATO nations were expected to follow the FRG's lead. At the DPC meeting last minute details were worked out among the partners and the multilateral MOU referred to at the beginning of this section was signed, and the immense intergovernmental and interindustrial coordination effort for this unprecedented NATO acquisition was finally virtually settled. Final issues remaining to be solved were Belgian government approval (at that time under a caretaker government), endorsement by the various national parliaments, and French participation. The day following the signing of the MMOU, NAPO finally received its NPLO charter (previously being only a general provisional Program office). The new outfit was called the NATO AEW Program Management Organization (NAPMO) and it was shifted to a town in the southern Netherlands province of Limburg, Brunssum, several kilometers from the planned Main Operating Base on the other side of the border in the FRG. The framework within which this NATO procurement would take place was now established.

### 3. ORGANIZING AND MANAGING THE NATO PROGRAM

#### A. The Customer and the Contracting Framework

Thus ended for Boeing some three and a half years of wondering who their customer, i.e., 'NATO', really was.

Boeing had in the meantime been fielding the full range of challenges. This range stretched from the more usual ones faced by such programs as organizing an acceptable and flexible industrial collaboration program and the painfully slow process of obtaining the waiver of ASPR clauses that were unacceptable to the prospective European subcontractors, to those problems which resulted from the program's unprecedented nature such as that of unfunded program termination costs in the event the program was prematurely terminated by NATO. This latter problem resulted from the enormous financial obligations that the contractor and its subs had to undertake while not being adequately covered by scheduled payments in the MMOU.<sup>6</sup> This resulted in an unacceptably high imbalance between obligations and payments or guarantees for the contractors in the early years of production. In addition there is that aspect of doing business with a NATO subsidiary organization, especially disquieting for a program of this size, NATO's legal immunity.

The program management approach eventually worked out for this acquisition was to have Boeing contract directly with the NATO subsidiary organization, NAPMA, with the USAF's SPO acting as agent to NATO. Though this was not clear until

- o \$45 million for running the NATO agency, NAPMO, that would administer the project.

The planned spending rate was roughly \$250 million a year on the aircraft and \$6 million a year on the ground system modifications.

Britain bears the entire cost of its own AEW version of the Nimrod, and of the modifications to British airfields. Britain will however pay some 12% of the cost of modifying the NADGE system.

#### B. Government Agreement on Redistribution of Work

While most of the countries concerned have agreed to the terms of participation without too much difficulty, the center of controversy focused on the second largest contributor, the FRG.

Remaining firm on its position that substantial offset was required to help defray the costs of the AWACS system, the German government successfully negotiated the following offset for its participation: \$250 million of in-country work for the aircraft spread over a number of German companies; U.S. Army purchases of military vehicles and trucks for forces stationed in the FRG for a probable cost of \$80-90 million; and discussions with German telecommunications companies improving or modifying U.S. communications equipment and facilities in the FRG for a total package of about \$80-90 million. Another key offset area would result from the FRG being the site of

the Main Operating Base (MOB) for the AWACS systems. With an overall estimate of \$100 million for the annual operational support for the entire AWACS system, it is estimated that 50-65% will be spent on the MOB. Over 15 years of operation it is expected that the Germans will more than break even.

The work that is being second sourced for the production phase includes mission avionics systems and air vehicle components to be produced in the FRG and Canada by first and second tier subcontractors to Boeing, Pratt & Whitney, and Hughes. CAE of Canada provided the Flight Simulator directly to NAPMO via a contract with the Canadian Government's Canadian Commercial Corporation (CCC). The work includes subsystems of: the AWACS early warning and control radar; the panel systems for the air space surveillance and control functions; subsystems of the main computer as well as the communications and the data transmission and distribution system. German industry is also participating in the continued development and maintenance of the extensive software program of the total system.

This AWACS industrial collaboration package (i.e., internal offsets) amounts to about 15% of the cost of procuring the 18 E-3A aircraft. The greater part of this industrial collaboration package fell to eight German firms, but two Canadian firms also have received subcontracts (Canada being the third largest contributor).<sup>7</sup>

These firms are:

The FRG:

Dornier - installation and checkout of equipment in the aircraft plus ground support equipment under subcontract from Boeing.

AEG-Telefunken - communications and test equipment under subcontract to Boeing, plus radar elements under second tier subcontract from Westinghouse

Siemens - fabrication of situation display consoles under a second tier subcontract from Hazeltine and advanced communications equipment under subcontract from Hughes

SEL - advanced data processor elements under and second tier subcontract from IBM

ESG - software development under subcontract from Boeing

Liebherr - antenna drive under subcontract from Boeing

Diehl - Special test equipment (STE) under subcontract from Boeing

MTU - engine parts under subcontract from Pratt & Whitney

Canada:

o AWACS unique

- Litton of Canada - On-Board Test Maintenance and Monitor (OBTM&M) system and the associated STE (built to Boeing drawing)
- CAE Industries, Ltd. - flight simulator (designed to Boeing Spec but procured directly by NAPMO.
- Fleet Industries - TF33 engine nacelles

o 707 common

- Enheat
- Garrett Mfg.
- Leigh
- Fleet Industries

C. The NATO Program and France

An initial low-level interest in the NATO AWACS project by France picked up momentum in March 1977. As already mentioned, France showed some interest in getting the CFM-56 engine used on the AWACS, in return for a French decision to lock into the system through an annual subscription arrangement covering reporting, but not control, similar to that worked out previously with NADGE. The French government couldn't participate directly in such a purchase because of the usual Gaullist sensitivities vis-a-vis the NATO command structure. Imminent decisions on participation on the part of France's President, however, were postponed several times during 1977 and into 1978 until the

October 2, 1978 deadline for reengining the Boeing 707's with the CFM-56 engine without a delay in delivery to NATO, came and went. Therefore, when the MOU was signed in December, 1978, the status of France with regards to the program was still up in the air.

The DATEX 77 exercise, which tested French air defenses in the fall of 1977, had turned up some radar coverage deficiencies at low altitudes. Afterwards, Minister of Defense Yvon Bourges noted that, though new ground equipment would help cover these weaknesses when they came into service, USAF/Boeing E-3A AWACS offered the optimum solution. When the French moved up the following year's exercise to the late spring, the results showed only slight improvement. At the time it was reported that the timing and results of the two exercises appeared to be behind a decision by the French to contribute to the NATO AWACS program on an annual subscription basis. Yet as previously stated, a decision was still not made.

As of mid 1985, France was still studying a solution to its early warning requirement for the late 1980's (see Chapter 11 for the Boeing/Grumman offset proposals). By this time Boeing E-3A had established itself as the favored solution of the French Air Force. Prior to this options had included:

- Grumman E-2C;
- Using the British Marconi mission avionics utilized by the Nimrod for:

- An AEW version of the Dassault-Breguet new generation Atlantic ASW aircraft;
- An AEW version of the SNIAS C-160 Transall cargo/transport aircraft;
- An AEW version of the Airbus.

The Grumman E-2C had been definitively eliminated from the French Air Force competition by October of 1983, though the French Navy still seriously entertained the possibility of acquiring several E-2C's for use on their two nuclear powered carriers to be produced in the 1990's.

Then in January 1984 it was announced that the GE/SNECMA CFM-56 engine would be incorporated in the five Saudi Arabian E-3A's and eight KE-3A tankers which would allow the French to buy E-3's with significant French content (and a limited assumption of non-recurring costs).

The French Air Force decided on the E-3 in the fall of 1984. Budgetary political, and exchange rate problems however continued to delay the acquisition into 1986.

#### D. Contracting Procedures for NATO AWACS as Compared to the F-16 Experience

A GAO Report entitled, "A New Approach is Needed for Weapon Systems Coproduction Programs Between the United States and its Allies," April 12, 1979, recommended the direct sales approach used in the case of NATO AWACS over that of the FMS approach used with the F-16.<sup>8</sup>

The procedure governing coproduction programs including the U.S. and its allies is the same as that which govern Foreign Military Sales (FMS), and, in the opinion of the GAO, needed to be altered.

With the emergence of complex industrial coproduction programs such as the F-16, where foreign participants actually build a major segment of the equipment they purchase and even produce parts of a system which the United States will use, the foreign military sales procedures are inappropriate.

Coproduction arrangements give the involved parties rights and responsibilities that are different than those found in conventional buyer-seller relationships. Coproduction arrangements are essentially partnerships, while military sales are inherently transacted at arms length. The present foreign military sales procedures do not reflect these rights and responsibilities...

The basic premise of a foreign military sale is that, when selling a specific weapon system to a foreign government, the United States has the responsibility for insuring the delivery date, the quality of the product, and the reasonableness of cost.

In coproduction programs, however, the product's cost, quality, and schedule are greatly affected by each of the participants.

...The F-16 program offers many examples of the complexities of coproduction efforts and shortcomings of using the traditional foreign military sales procedures in coproduction programs."<sup>9</sup>

The F-16 program's MOU..."established the basic legal responsibilities of the United States vis-a-vis its customers. These legal commitments assumed by the U.S. Government included:

- furnishing required defense articles and services,
- passing on to the European participants any rights included in the price under any contract connected with the procurement of items on behalf of the purchasing European nations,

- repairing or replacing damaged or defective parts, free of charge,
- providing title warranty to all items sold to purchasers; and,
- accepting responsibility for all termination costs of its suppliers resulting from cancellation or suspension of all or part of the order.

The use of foreign military sales procedures thus imposed product responsibility upon the United States, even though the production was to occur in several countries where the United States was powerless to exercise the proper supervision necessary for a reliable product. In light of this situation, the European participants agreed to assume those contractual risks and financial liabilities to the same extent as assumed by the U.S. Government for the production taking place in the United States. Thus, in the F-16 program, which involved a precedent in international industrial defense cooperation, the foreign military sales procedures had to be modified to accommodate the relationships and responsibilities of the participants."<sup>10</sup>

In the GAO's opinion, "a direct sale contractual arrangement would more accurately reflect the relationships and responsibilities of the participants. Additionally, it would eliminate the U.S. Government as the contractual seller. The approach would overcome conflicts over national sovereignty voiced by American allies."<sup>11</sup>

As an example of this direct sale approach, the GAO report cited the purchase of the Boeing E-3A by NAPMO.

Since the United States had previous experience in acquiring the system for its own use through the American prime contractor, it was designated as agent to manage the program on behalf of NAPMO. The USAF E-3A SPO at Hanscom AFB near Boston and the local AFPRO in Seattle Det. 9 of the AFCMD provide the PCO

and ACO respectively for the program. The parties to the contract are the NATO AEW&C Program Management Organization and the U.S. prime contractor, Boeing. U.S. procurement practices are applied on the program except when they are inappropriate to foreign subcontractors and contracts. The obligation of funds are in the name of the NAPMO.<sup>12</sup>

In the AWACS direct sale approach, the following conditions exist:

- (1) Sovereign rights are respected as each nation participates and buys a weapon system as one body through a joint organization.
- (2) Procurement laws and regulations are structured to accommodate the sovereign rights of the participants and the national laws of each participant.
- (3) Management of the program would still be retained by the national government most qualified to assume this task.
- (4) Each participant has knowledge of the status of the acquisition and is able to protect its peculiar objectives through established organizational bodies.

The direct sale approach requires that contractors assume greater responsibility than they have had in traditional foreign military sales...From our review, it is evident that most major U.S. firms do have the necessary background.<sup>13</sup>

One specific example of the advantages of this approach cited by the GAO was the MOU's having agreed that foreign subcontractors (i.e., Canadian and German) would be subject to their own contract law and therefore to their own pricing law and audit by their own national agency. This was possible because it was a NATO subsidiary, NAPMA, that was making the purchase, not the U.S. Government as in FMS. This simplified somewhat the time consuming process of negotiating and obtaining approval of flowdown waivers to ASPR clauses, and provided a major reason for using the direct sale approach over the FMS approach (i.e., that used in the case of the F-16).

### E. The USAF as the Sales Agent

Throughout the long gestation period from 1975-78 there was no 'U.S.' position with regard to the program. No one in the DoD or Air Force was able to acquire and/or retain a charter. Unlike the F-16 project with Frank Shrontz, for NATO AWACS there was no one single person steering the project throughout. On top of this, ground rules kept changing during the program, making life difficult for the Pentagon, the USAF and Boeing participants. Then, of course, as things dragged on no one was ever quite sure the program would ultimately go, which undermined motivation and hamstrung the whole effort. On the other hand the program was fortunate in that at critical points the right people surfaced and resolved problems.

Originally the number of U.S. actors was kept small enough to work the special complex nature of the program. However, later in the program, it was thrown out to the mass of the bureaucracy, and it received the business as usual treatment. For the NATO AWACS project there was a lack of clear-cut government management, just a fluid series of actors (both organizations and people) over a number of years. At critical points, key U.S. advocates were lost through reappointment.

One example was provided by Dale Babione's plight in the Finance sub-group of the High Level Group (a sub-group which in fact was at a higher level than the High Level Group). Babione called the shots straight when allies became unreasonable. But he was undermined by other parts of the DoD, which were very nervous about the program, and bent on appeasement. Babione was ultimately replaced by General Bowman. Another example involved the

reappointment of a major U.S. advocate at a crucial stage in the debate over whether to make the sale FMS or direct.

In contrast to the U.S., the FRG was more effective at the governmental level, because they kept their team small.

Congressional liaison for its part, was generally considered to have been inadequate for the program. From Boeing's viewpoint, OASD/ISA was very cautious in giving data to Congress. As such, Congress never got the big picture. The DoD should have done more leg work in this area. Congress was often left in the dark, very often having no idea of what the real issues were. A case in point was the resurfacing in Congress in late 1980 of whether a new export license was needed, since Congressional approval had been for an FMS sales case. On the DoD side, it was felt that Boeing could have done a better job of conveying to the DoD its concerns and the rationale behind it, e.g. termination liability.

As for the issue of whether to coordinate the U.S. Government-Industry position first, or coordinate at the Government-to-Government level first, Col. Carlberg cited his F-16 experience. Frank Shrontz followed a practice of inviting in corporate people from the GD and Northrop teams to clear industrial commitments. However, as pointed out by Col. Carlberg, Shrontz was exceptional in that he came out of the industry side, knowing the importance of keeping industry in the loop, not in the dark.

Legal support was another area of the program where there was room for improvement in coordinating the U.S. position. Boeing's legal staff experienced frustrations in getting their ESD counterparts to deal with problems. Each time Boeing approached them on a particular problem ESD lawyers would pass the issue up, leaving it hanging until a last minute panic set in a year or two later. What was needed was having lawyers brought in from the beginning to support a client's position, i.e. solving problems instead of taking a narrow restrictive view of problems. For NATO/AWACS there was a lack of one dedicated SPO lawyer. The government lawyers at the ESD suffered from both institutional and motivational problems. Institutionally, ESD lawyers were not committed to finding solutions for the SPO.

The situation at the DoD could be contrasted with that of the ESD with regards to legal support. At the DoD level, if a point was arguable, lawyers were told Secretary of Defense Brown supported a given solution to a problem, and needed a legal position by tomorrow. The lawyers then became creative and solved the problem. Whereas if a point was arguable at ESD, lawyers didn't find solutions, they raised obstacles. Col. Koretz of the SPO felt the solution is to assemble a team of lawyers, one from each organization concerned. As a team, they could work to resolve problems and then go home to coordinate and maintain support.

As we've seen in previous agency relationships involving transnational enterprise, there is considerable room for ambiguity and fluidity as to the exact sharing of responsibilities. The NAPMO BOD considers the ESD SPO responsible for managing the NATO AWACS acquisition. However, NAPMA's General Manager

General Boy considers NAPMA as the principal entity responsible. How did the program find itself in this situation? Originally the principle axis was between the HQ USAF RDP at the Pentagon and NAPMA, with the RDP adjudicating any serious problems. But the RDP later abdicated. As the program progressed, the role played by RDP diminished, especially in the final days prior to the signing of the MOU.

The original U.S. offer had been one of active staffing and participation in the Hanscom SPO by participating European and Canadian governments (i.e. as in NATO PHM, NATO Seasparrow, F-16 and the German-American AVS fighter), with the U.S. acting as host country. This would have involved a smaller NPL0 in Europe, one dealing directly only with the ground environment. Unfortunately, though, in the opinion of Col. Koretz, the option of the U.S. acting as host country was abandoned too soon. In the final days before the signing of the December 1978 MOU, the DoD gave back to NAPMA responsibility which the nations had already agreed to give up.

Another critical issue that was left hanging was Configuration Management. The Configuration Management issue was surfaced by the Germans just several weeks prior to signing of the MOU. In the rush to settle outstanding issues and finally get on with the program, the RDP caved-in, passing on Configuration Management responsibilities.

## F. The MOU

The government-to-government agreements which govern the procurement were not the usual Letter of Offer and Acceptance (LOA) to a pre-existing foreign customer as in FMS programs. Instead, a Multilateral Memorandum of Understanding (MMOU) signed by the 12 member governments of NAPMO (of which the US was one) was drawn up, complemented by a bi-lateral Acquisition Agreement signed by the two parties, NAPMO and the US government. The negotiation of this MMOU is what took 3 1/2 years.

The MOU, as broken down in its Table of Contents was structured as follows:

SECTION	TITLE
I	Preamble
II	Scope of the Programme
III	Ownership, Insignia, Claims and Operations
IV	Programme Management
V	Government Services and Facilities
VI	Structure, Configuration and Interoperability
VII	Schedule
VIII	Initial Programme Cost Estimates
IX	Cost Sharing
X	Financial Principles and Procedures
XI	Industrial Benefits
XII	Exchange of Technical Information, User Rights and Protection of Technical Information
XIII	Contract Provisions

SECTION	TITLE
XIV	Operations and Support
XV	Formal Delivery and Acceptance Procedures
XVI	Inspection and Quality Assurance
XVII	Audit
XVIII	Research and Development Levies
XIX	Sales and Transfers to Non-Participants
XX	Taxes and Customs Duties
XXI	Security, Secrecy and Disclosure Arrangements
XXII	Admission of Additional Governments
XXIII	Withdrawal and Termination
XXIV	Effective Date and Duration
XXV	Precedence
XXVI	Language, Copies and Signature

APPENDIX	TITLE
A	Definitions
B	Bibliography of Documents
C	NAPMA Organization Chart
D	NATO E-3A Standard Configuration
E	List of ADGE Sites to be Modified and Augmented
F	Master Phasing Chart for Total Programme
G	Total and Annual Funding Requirements from Participating Governments
H	Aircraft Component Industrial Benefits

## APPENDIX

## TITLE

J	AEGIS Industrial Benefits Requirements
K	Estimated Annual Operations and Support Funding Requirements
L	Audit Arrangements for the Airborne System

The Multi-lateral Memorandum of Understanding (MMOU) and Acquisition Agreement predetermined many of the contractors rights, obligations and legal remedies. The U.S. government, as a party to these two documents, did not adequately address certain contractor concerns due to insufficient government/contractor coordination prior to committing the program on a government-to-government basis. It might be better to allow the contractor to be a party to the formation of those portions of the government-to-government agreements. This would lead to a better understanding of risks. Consequently, mitigation through the agreement can be considered while changes are still feasible.

The MMOU could have been clearer, more specific, and thorough. It did not contain supporting rationale for directions, and was not appropriately coordinated. The MMOU did not adequately address: indemnification for third party liability; termination liabilities; specific authority and responsibility of the management agencies (NAPMO, SPO, RDP); government-to-government peripheral offsets; nor customs, duties, and tax treatment.

A checklist for MOU preparation should be drawn up which identifies the major considerations that should be clearly addressed and understood at the outset of an interallied program. Many of these subjects are amenable to across the board solutions. Others are of an either/or type, or have a finite set of options or trade offs. The MOU can then be coordinated through the

governments to insure those departments involved understand their government's commitments.

This would greatly assist in the set up of future programs. More importantly, though, such a checklist would allow for a quality control-type audit of a given program. Such an audit could be constructive if it looked at elements, not detail, i.e. as a cross-check to ascertain that all required program elements had been addressed.

It was generally felt that it is best to deal with as many issues as possible in the MOU document. Whereas one must be cautious as to how far one goes in this regards, for this project, one major USAF participant felt the parties could have erred more toward specificity. If issues are adequately settled in the MOU, then the MOU can supercede legal issues, cropping up and chasing along behind it.

A need was also expressed for an aide-memoire to the MOU, i.e. a full documentation of meetings and rationale to back up the MOU. This would provide linkage between the documentation and MOU as with the intent of the U.S. Congress for a given piece of legislation.

Another issue was the allocating of common design costs. New capability and/or redesign benefit both the US and NATO. Likewise for any new customers. When the NATO E-3A program started there was not (and still is not) an approved/agreed to method of allocating the common non-recurring costs to benefiting customers. An MOU ordinarily spells out the way these costs will

be covered and how that arrangement would or would not be altered as new customers purchase the system. For the NATO AWACS this was consciously left open for future resolution.

In another area, the MMOU specified exemptions for payment of taxes, duties, and customs on NATO E-3A, but the FRG government did not provide a ready, workable operating approach to accomplish the exemption for value-added taxes. Although the MMOU provided for a tax exemption, it was never coordinated with the local FRG customs officials responsible for administration. The matter was further complicated by an obligation that subcontractor administrative costs associated with allocating and accounting for tax exemptions would be borne by the FRG. The pressure associated with hold-up of deliveries caused the contractor to be instrumental in getting affected parties together to resolve the issue. In the end the prime contractor initiated an "assignment approach" on VAT that results in no monies changing hands in the exemption process on value-added taxes. This allowed the charges to be flowed up through the contracting hierarchy and ultimately closed out (e.g. Dornier to Boeing to FRG Finance Ministry.) Government-to-Government agreements, be they MOU's or LOA's, need to identify responsibility and timing for an operating approach to tasks such as this one where a ready mechanism does not exist for implementation.

#### G. Planning, Budgeting and Scheduling

Certain issues required decisions that could only be made at the North Atlantic Council or Defense Planning Committee (DPC) level. Chief among these were the development of a cost sharing formula and the subsequent budgeting of

NAEW&C in the nations' five year plans. Industrial Collaboration was accordingly more difficult to formulate. Because the NATO DPC met at infrequent (six month) intervals, key decisions were delayed. This may have been a contributing factor to the U.K. dropping out in March of 77; newspapers reported that indecisions of NATO, combined with British Labor Union pressures, forced the U.K. decision. After the British had withdrawn Boeing had to restructure its offset program, shifting work packages from the UK to the FRG. Some quarters have suggested that authority for key decisions should be delegated for such multi-national programs to a standing body which meets often enough to preclude delaying the decision making process. The feasibility of this ever happening though is questionable. Such weighty matters generally require the high level endorsement that only the NAC or DPC can provide.

Likewise with NAPMA, which does not have the authority to commit funds. They must present requests for funding and program changes, even changing one position in the manpower plan, to committees that meet periodically on fairly rigid schedules. This lack of decision authority to commit approved funding is a disruptive factor in the orderly progress of a program. Initial planning and scheduling on the assumption that a NATO SPO-like management structure exists with decision making authority led to frustration and delays in program milestones.

An acquisition management agency must be given sufficient authority for day-to-day decision making within the allocated funds. However, given the

inevitability of the greater constraints for an NPLO than a national SPO, the USG and U.S. contractors must allow for this lack of authority and decisiveness and plan accordingly, i.e., greater lead-time is required for the decision making process which places a heavier demand on planning and often the need to resort to interim solutions.

Budgeting of U.S. commitments to NATO is on an annual basis while the European governments utilize a five year cycle. The U.S. practice of annual funding forecasting and budgeting fails to assure funding continuity and can result in non-productive replanning of programs. The European practice of five year budget forecasts on the other hand, provides funds for continuity and single thread planning that maintains funding stability and reduces cost growth. The U.S. should consider multi-year contracting provisions on NATO programs. This would make their commitments on equal terms with other nations, and provides coverage for cost factors beyond the control of industry.

The NATO AEWSC High Level Group initially pursued the program based on its own schedule requirements and configuration needs. This resulted in a significant "stand alone" cost penalty caused by departure from the U.S. program configuration and schedule. The later establishment of a single integrated schedule and configuration resulted in significant cost reduction and assured affordability of the NATO E-3A program.

Successful performance was also contingent on the utilization of integrated resources and sharing of assets. A problem to resolve early is the ownership and disposition of tooling and STE as it might pertain to further procurement of E-3A systems.

## H. Foreign Exchange Payments to the Contractors

For the NATO AWACS program a system to handle exchange rate fluctuations was set up similar to the one utilized by the NATO Infrastructure Program. The MOU, section X financial principles and procedures, describes the following financial principles which basically ensure that the prime and subcontractors do not realize loss or gain through fluctuations in currency exchange rates. Consequently they have no price for the associated risks.

- (1) The participating governments agree to initial schedules of payments which reflect each government's established percentage share of the cost of the program in constant currencies and which are phased to meet both national budgetary constraints and total program funding requirements.
- (2) The NAPMO is authorized to open commercial accounts in its own name in any or all of the currencies used and in any or all of the countries of participating governments.
- (3) The USG as Agent will have complete responsibility for effecting payments to the prime contractors from funds made available by the NAPMO, and will have sole authority to approve such payments.
- (4) In order to insure adequate program funding, the NAPMO will arrange for financial plans to be produced and updated at least

annually. These plans will identify all anticipated quarterly expenditures for the remainder of the program in all currencies required.

- (5) Contracts down to the third level will be concluded and paid in the currencies needed, which will be provided by NAPMA.

Reflecting the above principles expressed in the MOU, the NAPMA prime contract with Boeing (which, again, is administered by the USAF's ESD) also provides that the contractor and subcontractors shall not realize a financial gain or loss through currency exchange rate fluctuations. Fixed rates of exchange are used to reflect payments in "equivalent" U.S. dollars for prime contracts F1962-F-79-0052, -0053 and -0054. Pegged "program" rates are only used for internal accounting - no payments are made based upon these.

DM	2.34	(IC's)
CANADIAN \$	1.064	(IC's)
DUTCH GUILDERS	2.517	(BTMS & BOI ONLY)

Under the contract, Boeing is provided by the NAPMA with all currencies required for payments to subcontractors (i.e. both first tier foreign, and first tier US subcontractors with German subs) and is responsible for paying them in their national currency, i.e. mostly DM's, but also Canadian dollars. The Dutch Guilders were required to defray the costs of the Boeing Technical Management Services (BTMS) and Boeing Operations International (BOI) teams located in south eastern Netherlands at Heerlen to support NAPMO in Brunsum and the nearby MOB at Gielenkirchen in the FRG several kilometers away.

Boeing receives the necessary foreign currencies from the paying office at Hanscom Air Force Base (AFB), Massachusetts which has financial oversight of the contract. Boeing in turn provides these currencies to its subcontractors for them to cover their national currency and foreign currency needs. (Most of the dollar costs for non-U.S. subcontractors were incurred in the 1979 to 1980 time frame in support of lower tier procurement parts which had to be obtained from the U.S.)

Another key feature of the system is that Boeing is responsible for forecasting its non-U.S. currency requirements for payments to IC subcontractors on a quarterly basis. Non-U.S. currencies used in prior periods are also reported by the contractor. Once the currencies are received by the contractor, prompt payment by Boeing and its first tier US subcontractors to the IC subcontractors is required.

(b) Availability/Disbursement of Funds to the Contractor

The procedures for making available non-U.S. currency to the prime contractor for payment of IC subcontract effort and U.S. currency available to IC subcontractors for payment to U.S. contractors follow: (See figure on following page).

- (1) Contractor requests U.S. and non-U.S. currency on invoices forecasting payments in respective currencies, to IC subs.
- (2) ACO reviews for allowability and certifies.
  - (a) Notifies NAPMA by electronic message to make non-U.S. currency to contractor.
  - (b) Forwards copy of payment voucher to HAFB for U.S. currency to contractor.

- (3) (a) NAPMA provides contractor with forecasted non-U.S. currencies obtained from US and other countries.
- (b) HAFB provides U.S. currency to contractor for payment to IC subs.
- (4) (a) NAPMA provides HAFB paying office with copies of paid vouchers.
- (b) Contractor pay IC subs U.S. currency.
- (5) (a) Contractor pays IC subs in non-U.S. currency.
- (b) IC subs pay U.S. contractors.

The Funding procedures described above are more extensive and costly than in U.S. programs. NAPMA required more accurate and more frequent funding forecasts than on the USAF program. This was required because the nations are naturally disinclined to provide funds until they are needed as they lose the imputed interest on the funds given to NAPMA. Some currency shortfalls occurred during the early program phase wherein subcontractors could not be paid because currencies were not available. However, as we will see later, the pendulum swung the other way in the last year of the program.

Capitalizing on one of the lessons learned from the prior NADGE project, the responsible NPLO, NAPMA, was allowed to put funds from the nations into interest bearing accounts and use the earned interest as a reserve to offset possible future funding shortfalls from any of the nations. This helped prevent delayed foreign subcontractor payments and thereby further contributed to a reduction in the total cost of the system to the nations.

## I. Distribution of E-3A Technical Data to Foreigners

Security procedures must be established early by joint coordination with governments involved. Releasability and over classification did cause serious data flow problems early in the program. At one point, NATO indicated that all spares listings would be classified NATO Secret. That would have entailed 80,000 frequently updated computer pages. The cost of such over classification would have been enormous. Early planning by management from NATO and the USG is necessary to preclude major impact. All parties involved should be brought on-board with thorough briefings and published easy to understand rules.

Also, many months passed before specific, reasonable, and understandable rules on releasability could be developed. Conduct of sophisticated, high technology programs such as the E-3 program in an environment where program foreign nationals were assigned and working with Boeing and the SPO presented challenges in the area of disclosability of technical data to foreigners. Innumerable problems cropped up with the determination of whether archive data and newly created data was foreign disclosable, or not along with ensuring adequate protection against inappropriate/inadvertent disclosure.

In order to minimize these problems the National Disclosure Policy Committee (NDPC) and ESD moved quickly. Due to the complexity of the program, the unusual step was taken of appointing an alternate ESD Foreign Disclosure Officer (FDPO) to The Boeing Company. Through this assignment, ESD/IND provided (in the person of Ernest Lowe) an extension of its office which was

to help expedite Foreign Disclosure Policy decisions and release authorizations. Ordinarily, all applications by contractors for export licenses for technical data and/or hardware, as well as related to the NATO E-3A program are submitted directly to the State Department's Office of Munitions Control (OMC). The OMC then staffs these out within the State Dept and over to DOD. Instead, in order to ease the administrative burden involved, all submittals were to be directed to the FDPO at the Boeing/Seattle facility for preliminary staffing prior to forwarding to the state department's OMC with its recommendation. Being on-site at the prime contractor, the FDPO had the data and people at his fingertips which would allow for a rapid determinations on foreign disclosure/export licensing issues impacting Boeing and its subcontractors.

The establishment of a qualified representative (ESD/INDB) at the prime contractor's facility in March 1979 provided for expeditious development and maintenance of implementing procedures to the USG disclosure policy. Implementation of foreign disclosure approval in an expeditious manner by the Seattle based FDPO allowed the flow of data between Boeing and foreign nationals residing in Seattle, ESD (near Boston), NATO agencies and IC subcontractors to proceed quite smoothly.

## J. Testing

Several of the problem areas involving testing were not all that different from what would have been encountered on a purely national program.

- Approval of test directives on a timely basis was a problem in earlier phases of the U.S. program (where they were submitted in accordance with the CDRL). This was corrected for the NATO program by the creation of a Test Directive Sub-Working Group (TDSWG). To alleviate this, a Test Directive Sub-Working Group was set up which met monthly to review available TDs, which were submitted by Boeing as soon as they were written.
- Functional Configuration Audit (FCA) was unnecessarily slow due to insufficient documentary linkage between test results and the specifications.
- The need to provide local (Seattle) SPO authority to approve non-controversial Acceptance Test Procedure (ATP) changes such that Boeing can immediately release the procedure change and avoid unnecessary delays in closing IRSO's.
- The need for sufficient seats on the aircraft to allow maintenance of currency for flight and mission crew members from both Contractor and Joint Test Force during flight test.

K. Frequency and Flight Authorizations in Europe

As with prior NATO programs, involved in communications and electronics frequency authorization was an issue. Communication and radar operating frequencies were not obtained for the NATO AWACS in the time schedule initially set up. Boeing and ESD recognized the need to submit NATO program

frequency clearance requests early and did so starting in July 1979. The status of frequency clearance requests through the various U.S., NAPMA, National and Allied Radio Frequency Agency (ARFA) processes proved to be very difficult to ascertain not unexpectedly due to the multiple agency coordination involved. delays developed. Its advised that for future porgrams we continue to submit frequency clearances as early in a program as possible, but then also maintain management cognizance of the status, and initiate follow-up action as may be required.

Takeoff and landing limitations identified at airfields in the FRG impacted flight programs at DRW. Local community groups concerned with the environmental noise impact associated with takeoffs and landings were instrumental in 1979 and 1980 in obtaining state and local government limitations on flights out of DRW's Oberpfaffenhofen facility. Limitations are 4 flights within a calendar month period. Early identification of operating restrictions to "home country" MODs during the selling phase of a program will enable action to be taken to achieve favorable limits when new program business leverage can be applied.

#### 4. Transnational Subcontract Management and Planning

##### A. Redistribution of Work

In major procurements involving foreign governments, since the late 60's offset has increasingly become an issue. It may be a matter of U.S. government or contractor provided. The latter is more common for sales of U.S. systems. Offset can include work from other systems, outside the specific program or contractor team, or participation by foreign industry in the manufacturing, final assembly and/or test of the specific equipment being procured. In the case of E-3A program it involved a mix of all of these.

##### 1. Organizing the Second Sourcing Effort

For the E-3A sale to NATO, Boeing agreed to spin off specifically identified E-3A work packages. Though this originally included the industries of all funding nations this was ultimately reduced to those of the larger contributors only. After the UK had dropped out in May 1977, and the French option to join had expired in October 1978, this included only the FRG and Canada. Industrial Collaboration (IC) as a means of offset was negotiated on the basis of tasks (statement of work) rather than specific percentages or fixed dollar commitments. This allowed the prime contractor greater latitude in working with the prospective industrial collaboration subcontractors in establishing second sources, while avoiding unnecessary contentions over whether the committed fixed value of work is being fulfilled.

In response to a Request for Proposal (RFP), issued by the U.S. Air Force on behalf of NAPO, Boeing established a goal to secure 25% Non - U. S. industrial participation in the NATO E-3A Program. It was planned to distribute industrial collaboration between the participating NATO countries as equitably as possible. In compliance with the RFP issued under Contract Definition effort F19628-76-C-0018, Boeing furnished the Brussels based NAPO with a list of European and Canadian bidders for several industrial collaboration activities. NAPO, in RFP No. F 29628-76-R, specified that "to the extent practicable, a reasonable and equitable share of the NATO AEW Program -- in terms of value, employment benefits, as well as technological and system know-how, shall be realized by participating European/Canadian industry".

The subcontract management organization supporting the original 34 aircraft USAF program was broken down by subsystem in the usual manner (e.g. the Westinghouse surveillance radar group, another group for the IBM computer, one for the Hazeltine data displays, a purchased equipment group, and so forth). When the 18 aircraft NATO program came along the three major U.S. subcontractors just mentioned shifted a share of their work on the 18 aircraft buy over to German firms, which thereby became second tier subcontractors to Boeing. This involved only a limited incremental effort or change in modus operandi at the Boeing level. However, work that had previously been done by first tier subcontractors, but is then shifted to second tier, involves certain complications that will be treated later.

Along side this original core organization broken down by functional group two additional subcontract management groups were grafted for the NATO program.

These NATO groups were responsible for managing that part of the work that had previously been accomplished in-house at BAC for the USAF aircraft. For the NATO aircraft however, this was to be second sourced to the industry of the next largest program participant, the FRG. One NATO group was responsible for the assorted hardware manufacturing work packages ordinarily accomplished in-house but which was now spread across southern Germany on a build-to-drawing basis.

The other NATO group managed the installation of mission equipment into the aircraft and checkout of the total system prior to delivery to the customer. As both elements of the NATO effort managed directly by Boeing had not previously been accomplished outside of the company, they were not simply transferring work from the original U.S. source, over to a German source for the follow-on 18 aircraft buy.

In only one case, with ESG, was there developmental work. This involved the NATO software package.

Boeing found that planning and organizational development for transnational subcontract management requires early consideration of several points:

- The need for earlier and more thorough functional planning under the guidance of subcontract management to reduce the rate of change required once the program is under way (e.g. detailed facility surveys, establishing resident teams, targeting and working critical contractual issues, and the construction of a top to bottom

drawing/specification tree). Once these problems have been addressed follow-on negotiations will be accomplished more easily and the general attitude of the entire program will be much improved.

- Establish and maintain the proper lines of communication with the foreign subcontractors as well as within one's own organization. This involves the establishment of an appropriate focal point both at home and on site. This is necessary in order to maintain a coordinated team approach, with all functional groups pulling in the same direction at the same pace.
- Develop effective methods for the transfer of data and drawings and assisting the foreign subcontractors in assimilating the technical package, once transferred.

For instance, Boeing was able to work the technical portion of the planning up to a point, but was not able to follow through, with gaps and miscommunication resulting. This necessitated redirection to the industrial collaborators and additional cost or schedule impact. It was found that Engineering/Configuration Management should specify as-designed requirements, change control, and change accountability for delivery of the products. Manufacturing/Quality Assurance must specify the as-designed (versus as-built) data, representing the Manufacturing and Quality Assurance activity. These tasks when specified should be integrated and made known in detail to the Subcontractor. Lack of integration of these requirements causes confusion.

## 2. Setting up for Outside Production in Europe

Here we will cover only the two largest of the resultant BAC subcontract packages, the hardware manufacturing accomplished by AEG - Telefunken and the system installation and check out (I&CO) task done by Dornier. As previously mentioned, the tasks to be accomplished by these two German firms was at that very time being handled in-house at Boeing for the USAF E-3A program.

Similar scenarios unfolded for the smaller BAC packages handled by Diehl and Liebherr in the FRG or Litton of Canada, as well as the large packages spun-off by the three major subcontractors Westinghouse, IBM, and Hazeltine to AEG, SEL, and Siemens respectively.

In the way of an initial comment, the set up of the AEG and Dornier sub-contracted efforts from source selection, through contract award and finally to contract definitization, were strung out over a total of 5½ years. During this period the contractor team faced a highly unstable baseline both as applies to the Statement of Work (SOW), the terms and conditions, and the ultimate customers.

For starters, the AWACS was not yet operational with the USAF until well into the NATO sales effort, so the configuration was far from a mature one. Then there were the NATO required enhancements which were a condition of sale to the second customer. The two most significant upgrades were the improved maritime (or overwater) capability for the surveillance radar and increased data processing capacity for denser air traffic, both of which were needed for

the European environment in which it was to be deployed. As the design changes resulting from the DDT&E effort on these and other subsystems percolated up and down throughout the E-3, system RFP's had to be revised and reissued.

Likewise it took several years for the hybrid contractual framework to fall into place as the ASPR flowed down from the prime contract and met with the German subcontractor needs which flowed back up through Boeing. Ultimately accommodation was obtained on both ends but wrinkles continued to appear throughout the duration of the program in the subcontract and property administration efforts. Just taking subcontract administration, the AEG and Dornier subcontracts incorporating numerous German (VOPR) provisions took almost two years to definitize following subcontract award. This was due to the Air Force ACO's refusal to provide consent until exceptions as to contract type (i.e. fixed fee), or provisions such as billing schedules and fixed conversion points could be hammered out.

Meanwhile the subcontractor base was expected to mirror the unstable customer base which had to be descoped and work packages recompeted as the all Europe plus Canada second sourcing requirement evolved into a UK, FRG and Canada and finally only an FRG and Canada industrial collaboration base. Furthermore, throughout this process the French continued to sit on the fence which kept the reengining option open.

Normal source selection techniques are not sufficient with multi-national programs, such as NATO E-3A when Industrial Collaboration is involved. Boeing

found that certain bidder and source selection criteria avoided risks on NATO E-3A. They included:

- Bidder list reviews by the MOD's concerned provided bidder credibility and experience. Source surveys were used to confirm MOD recommendations.
- Competition where possible. Recognize that the prime contractor is ultimately responsible for sources selected regardless of customer influences. Competition provided a good look at available sources and contributed to holding prices down.
- Selection of sources with ultimate customer rapport can improve communications, expediting understanding and the resolution of I.C. subcontractor problems.
- Familiarity with U.S. ways of doing business expedited understanding and accomplishment of tasks in an environment where U.S. data packages are used by European subcontractors.
- Recognition of subcontractor motives for seeking business plays a role in sound subcontractor selection and task accomplishment.

a. Source Selection for the Electronics and Communications Equipment Package

Boeing subcontracted for the manufacture of the various communications consoles, cabinets racks, and assorted avionics rather than make them in-house as

is the case in the U. S. Production Program. The most complex package among these involved the avionics; the Interface Adapter Unit (IAU).

Early in 1975, Boeing and its principal subcontractors began preparing a list of those foreign suppliers (both European and Canadian firms) that appeared to have the capabilities of supplying Electronic and Communications equipment for the proposed NATO E-3A Program. The following sources of information were used in preparing this list:

- Current offset program experience.
- Previous international procurement information.
- Past Foreign Industrial Survey Reports.
- Documented visitations by international trade missions, capability brochures, and industry trade publications.
- Foreign Consulates.

A determination was made as to the primary and secondary product line of each company. This information was matched against the Candidate Item List and the preliminary Bidders List was established. The preliminary Bidders List along with the Candidate Item List were submitted through NATO to the respective Ministry of Defense (MOD) of each country involved for concurrence. After adjustments were made to incorporate the recommendations from the MOD's, letters of inquiry were forwarded to each company on the list. These letters contained an abbreviated equipment description of the Communications/Avionics hardware and requested a statement of their interest in receiving a formal Request for Proposal (RFP) package.

RFP packages were then forwarded to the potential bidders consistent with their responses in August 1975. Companies submitting bids on Electronic/Communications equipment were:

Buhl Automatic	Copenhagen, Denmark
NEA Lindberg A. S.	Ballerup, Denmark
Hurel Dubois	Meudon La Foret, France
AEG - Telefunken	Ulm, FRG
Honeywell G.M.B.H.	Maintal, FRG
LITEF	Freiburg, FRG
Rohde & Schwartz	Munich FRG
Standard Elektrik Lorenz (SEL)	Mannheim, FRG
Kongsberg Vapenfabrikk A/S	Kongsberg, Norway
Nera	Bergen, Norway
British Aircraft Corporation	Bristol, UK

Following the distribution of the RFP packages, capability surveys were conducted at supplier plants for certain high leverage packages. Of the eleven (11) potential sources, all were considered to be "Acceptable", however, two were not surveyed as their proposals were either non-compliant or non-responsive for other reasons.

In the Model "B" Industrial Collaboration Package, AEG - Telefunken was the selected source for the majority of the Communications/IAU hardware. Based on this competition, a subsequent decision was made to combine all Communications/IAU items in order to obtain more effective management control

at a reduced price. The "NATO AEW Materiel Procurement Review Board Communications Group" Source Selection Presentation was made on April 2, 1976.

When the Model "C" RFP was issued several months later in July, it specified that where one source was identified previously, in the Model "B" Proposal (except in the case of I&CO), then only that source should be asked to propose on program changes. The RFP then specifically directed Boeing to utilize AEG -Telefunken as the single source for supplying NATO E-3A Electronic and Communication equipment that was being re-directed to Europe. No other sources were subsequently contacted or asked to propose prior to the award of this subcontract.

After the initial RFP Package was forwarded to Telefunken in August 1975, a number of requests for revised or "up-dated proposals" took place during the next several years. After several update request of the initial proposal, subsequent to British withdrawal in July 1977, Boeing requested AEG - Telefunken to revise its July 1976 proposal to consider a quantity of eighteen (18) shipsets of hardware and not twenty seven (27) as they were previously directed. This change also introduced new items and modified the requirements.

Again on April 14, 1978, Boeing requested AEG - Telefunken for an update to their August 26, 1977 proposal. AEG - Telefunken was asked to consider an October 1, 1978 go-ahead, along with revised drawings, quantities, and such. AEG -Telefunken responded with a revised proposal on June 2, 1978. This

proposal was the basis for the negotiation consummated July 27, 1978 and established what was finally to become the basic price of the subcontract.

A Firm Fixed Price (FFP) type subcontract was used for this procurement as it was judged that adequate drawings and specifications were available, i.e., this order was to be a build-to-drawing effort. Use of a Firm Fixed Price subcontract provided maximum cost incentive (since the total amount of underrun or overrun is borne by the subcontractor), and reduced Boeing's administrative cost and exposure. The seventy-three (73) items on the AEG purchase order represented various items of communication consoles, cabinets, racks, and panels, associated special tooling and test equipment (STE), as well as pertinent items of non-recurring cost such as translation and drawing conversion. Additionally, the order covers the fabrication of certain test equipment which was to be manufactured by Telefunken and shipped to Dornier for their use during the I&CO effort.

As AEG - Telefunken was a recognized European manufacturer of military hardware and had previously successfully performed on another U.S. Government contract the Klystrons, for USAF DDT&E E-3A's as well as production under license of a U.S. system as part of the NATO Hawk program. Even though this was an initial award, past performance by this supplier on the U.S. E-3A Program had indicated that AEG was capable of performing in an acceptable manner. The Request for Proposal, subsequent negotiations and the initial release of this order was predicated on the core configuration. Boeing intended that the actual requirement would be changed to the standard configuration including enhancements. This most probably would result in a

price increase with some impact to hardware delivery. It was understood that the subcontract would require close monitoring on the part of the buyer to minimize any cost and schedule impact resulting from the incorporation of the new configuration.

As one schedule slide succeeded another during 1976, 1977 and 1978 , in order to maintain program continuity, AEG - Telefunken ultimately agreed to continue working at its own risk, pending the award of a contract to Boeing by NATO for the design, development, test and evaluation of the AWACS. This "Assumption of Risk Agreement" was to continue from October 16, 1978 through December 31, 1978. Since Prime Contractor Authorization was not received during this period, the Assumption of Risk Agreement was extended by Telefunken to January 31, 1979. Prime Contract Authorization was received by Boeing on January 25, 1979 and Advance Authorization was extended to AEG -Telefunken by Boeing on February 8, 1979.

b. Source Selection for the Installation and Check-Out (I&CO) Task

Responding to the unfunded AWACS RFP issued on behalf of NATO by the USAF's Electronic Systems Division (ESD) at Hanscom Air Force base near Boston, Boeing compiled a bidders list, reviewed it with both NATO and the MOD's, and during the summer of 1975 conducted surveys in Europe. For off-load of the I&CO task seven firms in the three principal customer countries were involved:

- France
  - Aerospatiale
  - Dassault-Brequet

- The FRG
  - Dornier
  - MBB
  - VFW
- The UK
  - BAC
  - Hawker - Siddeley

In September 1975 Boeing issued an I&CO RFP to all seven firms. Proposals were received in January from all the companies except to the two French firms which declined to bid.

Primary criteria for selection of bidders for the NATO E-3A installation and checkout effort were:

- Customer geographic limitations requiring placement within NATO customer nations other than the United States.
- Companies financial capability to handle a contract in the \$50 M to \$80 M range.
- Large, multi-engine jet aircraft experience.
- Adequate facilities for large aircraft modification.
- Integration and test experience of state-of-the-art avionics.
- Competent management organization.
- Experience in working to U.S. standards and specifications.
- Bidder interest in participation.
- Assessment of Boeing survey team sent to Europe in September 1975 to verify company capabilities.

All companies submitted either fixed price or ceiling ( e.g., German VOPR) type proposals. In February, 1976, customer direction was received which delayed program go-ahead from July, 1976, to January 1977. All bidders were asked to revise their proposals in accordance with the new delivery schedule and information provided by Boeing. On-site fact-finding and source surveys were conducted by Boeing at all bidders' facilities during late February and early March, 1976. All updated proposals were judged to be compliant with RFP and all bidders were judged to be acceptable sources. As a result of the updated proposals and on-site visits, a source selection recommendation was established in April, 1976. Based on each proposal being evaluated against the above criteria, British Aircraft Corporation was recommended as the E-3A I&CO source for "Model B" proposal submitted to the customer April 30, 1976.

Shortly thereafter in July, 1976, "Model C" Prime RFP F19628-76-0429 was issued. Many configuration and schedule revisions were involved, along with the customer's position on Boeing's recommended source.

Section C III, Paragraph III, of the -0429 Request for Proposal, stated only the sources shown in Table I were to be solicited. Table I identified Hawker Siddeley Aviation, Limited, and British Aircraft Corporation as finalists in the I&CO competition.

Subsequently, RFP 2-4470-2030-196, dated July 23, 1976, was issued by Boeing to the two U.K. finalists along with a revised SOW. "Model C" proposals were received from both finalists on-site in the U.K. on September 1, 1976, by a Boeing team which commenced immediate proposal fact-finding and resurvey of

both bidders. The same criteria used to evaluate "Model B" was used for "Model C".

British Aircraft Corporation was again recommended as the E-3A I&CO source in October, 1976. Negotiations were proceeding with the two U.K. firms when in early 1977, the U.K. withdrew from the NATO E-3A program.

Following the withdrawal of the U.K., Boeing was directed to recompute the I&CO effort among the three German firms previously involved. Preliminary Request for Proposal 2-4470-2030-452, for "Model C-77" was released in July 1977.

To assist the firms in compiling their bids, a Boeing team was in residence in the FRG from July 6 to August 19, 1977. Proposals were received August 29, 1977, in Seattle, Washington.

The evaluation and selection recommendation was that followed based on best overall capability to accomplish the I&CO task with the most credible cost proposal.

Beginning September 19, 1977, on-site fact-finding survey was made utilizing a Boeing team comprised of seven members from Materiel, Engineering, Operations, Manufacturing, and Cost Management. Each of the firms were provided a critique of Boeing's findings at the conclusion of the visit, and given seven days to provide an update to their proposal. Each bidder responded. The team then returned to Seattle finalizing conclusions and recommendations by team members and a management review board.

On December 1, 1977, Boeing made a joint presentation to ESD/NAPMO identifying Dornier as Boeing's recommended source. Six months later on May 31, 1978, Boeing was advised by the customer that they could announce Dornier as the selected source for the I&CO effort.

## B. Administering the I&CO Subcontract

### 1. Differing National Cost Accounting Standards and Audit Practices

Since European contract types differ from those in use in the U.S., conflict with our defense contract regulations is inevitable in some areas. Per Section XVII of the MOU on Audit, and Appendix L on Audit arrangements for the airborne component IC subcontractors, national pricing regulations, (including contract-type), were to apply for IC subcontractors.

FRG pricing regulations (VOPR 30/53) include contracts that are similar to U.S. contracts but include several variations on interim target pricing agreements leading to a fixed price. Fixed price incentive contracts are not provided for in the FRG. Without incentive contracts, one of our standard inducements for keeping costs and prices down on other than FFP contracts is lacking. Further, "bail out" by the government seems to be resorted to more often as a solution to cost overruns. This can create a difficult cost control environment for U.S. contractors.

As European cost, audit, and analysis practices often differ from those of the U.S., they require special attention in a contract arrangement where the subcontractor's law determines the final price.

Reliance upon the FRG's Annex to VOPR 30/53, Directives for the Determination of Prices (Leitsätze für die Preisermittlung auf Grund von Selbstkosten) for the I&CO subcontract was difficult for Boeing. Problems resulting from allowability and allocability of costs being in accordance with contractors national pricing regulations included:

- German accounting and pricing systems are not compatible with U.S. government cost accounting standards (CAS). Furthermore, the U.S. CAS (and their flow-down) is unacceptable to most European subcontractors. Exclusion of prime contractor audit rights by German subcontractors leads to a dependence on national government audit. This however results in limited use of audits for negotiation purposes and price acceptance with less substantiated rationale.
- Prior review of findings between audit agency and subcontractor further limits audit use by contractor. The audit agency may accept labor and material costs proposed with little analysis made, making it difficult to achieve equitable settlement based on contractor analysis. Most audits are normally used for settlement, as opposed to techniques for negotiation. Audits are often delayed merely because the subcontractor is not ready.

Early recognition of contract types available by both the prime contractor and government customer(s) are necessary. Appropriate national contract types should be selected from the national range available.

The U.S. government and contractor must understand and be prepared to recognize national pricing laws and audits. Subcontractors for their part must recognize and accept that audits will be considered advisory only by contractor/customer. Furthermore, they must also accept the prime contractors right for substantive fact finding. Appropriate recognition should be reflected in the MOU to provide flexibility for audits so the contractors are not locked in by conflicting national audit standard practices such as those involved with U.S. DAR and the FRG's VOPR. Added emphasis on audit timing is also required. Including specific language in MOUs may help reconcile differing practices with regards to audit.

## 2. Flowdown of Prime Contract Clauses

More generally, U.S. government contracting clauses cannot be flowed down in many instances because they are inconsistent with German law. They are not accepted in other instances because they are unfamiliar and misunderstood.

U.S. clauses, such as socio-economic, U.S. protectionist, U.S. rights in technology, standard U.S. termination clauses, U.S. arbitration, and warranty are resisted by I.C. subcontractors who not unexpectedly demand "own country" clauses. (Some U.S. clauses conflict outright with European laws.)

DAR waivers need to be established in a timely manner for NATO Contracts. U.S. clauses that conflict with European laws should be identified and disposition accomplished during MOU preparation phase. Acceptance of other U.S. flow down clauses often can be accomplished by careful explanation of back-

ground and nuances. Compromises should be explored. The contractor found this to be more productive than flow-up to customer governments. Customer waivers and deviations requests are a last resort.

### 3. Payment Practices

European payment arrangements differ from U.S. practices and in some cases cannot be tolerated in a U.S. contracting environment. European subcontractors expect advance payments and interim payment methods rather than "on-delivery" payments. They are used to receiving progress payments and billing schedules, on a basis which is often unrelated to performance. Some of these practices are unacceptable in DAR.

Subcontractors were firmly advised at the outset, during this initial proposal phase, that the NATO E-3A contract had no provisions for advance payments and that subcontractors who demanded them could not be considered. This approach resolved the problem. Persistent negotiations between Boeing and the USAF Administrative Contracting Officer (ACO) on one hand, and Boeing and Dornier on the other, resulted in measurable billing schedules being established for other than the FFP type contracts. For FFP contracts payment upon delivery or at least certification of completion was ultimately agreed to. Until mutually acceptable billing methods could be worked out, the ACO serving as agent to NAPMO held up the required customer consent of the Dornier and Telefunken subcontracts from mid-1980 into early 1981. This was one of several issues that contributed to subcontracts being undefinitized for a period of about two years following the initial award.

#### 4. Third Party Liability

There is a possibility of catastrophic third party liability for some IC sub-contractors. German aerospace companies expected indemnification for third party liability on NATO E-3A similar to that provided by their own government. This became a significant problem with DRW, and alternatives were considered involving commercial coverage by Dornier. Program costs precluded implementation of this approach. The DRW problem was flowed up by the prime contractor and ultimately resolved by NAPMA when it obtained the nations approval for DRW indemnification. However, the problem with other subcontractors remained open. As mentioned earlier, future programs should include coverage in the MOU for customer third party indentification.

#### 5. Industrial Safety Standards

German laws concerning safety are basically industrially oriented and are based on insurance or social laws. FRG safety standards are basically industrially (shop) oriented, as opposed to U.S. E-3A criteria, which are design or weapon system oriented. Thus, the FRG standards are not readily adaptable to the NATO E-3A safety program for such activities as functional and integration testing of equipment, or equipment installation. In addition, the FRG safety regulations (Tuv) are complex and sometimes very nebulous. Interpretations of these laws are made by company safety engineers and/or German agencies. These interpretations are authoritative and must be adhered to. Modifications to U.S. manufactured equipment along with equipment built

by IC subs to U.S. drawings have been required because of these interpretations.

Early coordination with cognizant safety agencies is required to determine criteria and for advance review of equipment impacts. The Boeing Safety Requirements document and E-3A Program Ground Safety Plan were provided to Dornier for guidance in developing safety criteria. It must be emphasized that equipment modifications to meet foreign standards must be identified early and kept to a minimum and that only minor deviations will be considered later.

## 6. Q.A. Systems

IC Subcontractor Quality Assurance Systems and comprehension of contracted QA requirements lacked understanding and discipline. The NATO contract added special provisions to the Allied Quality Assurance Publications (AQAP) requirements, because of the more passive nature of the AQAPs in comparison with MIL-Q-9858A. The IC subcontractor's need to acquire an understanding of these more complex disciplines, objective evidence requirements, and delivery procedures significantly impacted implementation.

This problem was anticipated by the contractor and consequently the BTMS team was staffed with personnel qualified in the various QA disciplines. BTMS provided a high level of QA training, direct support to the IC subcontractors for procedure preparation, non-conforming material control, etc. Perseverance and continued monitoring of IC progress was required.

## C. Communications

### 1. Modes for Communication

For any contract administration effort of the scope and complexity of this one it is standard practice to set up a communications network. The network consists of multiple modes of communication. A cost-effective mix of these modes needs to take into consideration trade-offs between, volume, speed, reliability and cost. The modes, apart from travel, include scheduled daily teleconferences, individual telephone calls, regular and express pouch mail system for volume (twice weekly with three to four day delivery lead-times), and word processing/data transmission systems for alert, monitoring of parts shortages, hardware delivery and the repair cycle.

For the pouch mail system, in particular, more planning should have been done to preclude and/or minimize the conditions initially experienced, e.g., inventory of contents, allowable contents, and dealing with lost or late shipments.

The resident teams live and die by what is shipped over and in many cases the job suffers when the required data is not received in a timely manner.

### 2. Dealing with the Language Barrier

Though it is easy to come to feel comfortable with the language capability of English speaking foreign counterparts, the language barrier is real. There

will be a higher than usual level of distortion or loss in communication when one party is operating through a second language. Several pointers on dealing with this problem acquired by program people were:

- The need for patience and repetition followed by a feed-back cycle, having the foreign counterpart repeat the information back so as to ensure that they fully understand. This must be done while avoiding talking down to them. Lack of interruption, or nodding that one understands, does not necessarily mean full comprehension. The speaker must take deliberate steps to ensure the listener understands.
- Vigilance must be maintained with regards to the use of plain, clear language, and the avoidance of slang and accronyms;
- Presentations must be slowed down and important items must be handled through written correspondence;
- It is mandatory that a thorough agreement on detailed procedures be reached before production contracts are released. A review of the material sentence-by-sentence seems to be the best way to accomplish this, and it could mean the difference between success and failure.
- Face-to-face, functional-to-functional communication is more effective than formal group presentations. A greater sense of hierarchy often limits participation in the presence of superiors.

- The need to employ personnel in the resident teams with dual language capability to work directly with the local workers.

### 3. Resident Teams

Resident teams are an integral part of any major subcontract and/or licensing effort. They are necessary for a smooth flow of information and materials. They must be staffed and in place as early as is reasonably possible. Finding the right people for the job that are also willing to relocate, is not an easy matter, either.

All parties should remain vigilant in the face of the natural tendency of resident teams once in place, to operate as separate entities. One must ensure that resident personnel do not enter into small contractual commitments without the knowledge or approval of subcontract management.

Resident teams help avoid inordinate visitation of the subcontractor and the resultant disturbance this can lead to. For firms located on the U.S. west coast, the need to keep headquarters in the loop while minimizing visitation is further complicated by the constraints of a nine hour time difference. This leaves a very short time for the two to interface, thereby increasing the responsibility and work load placed on the resident team while limiting the ability of headquarters to provide guidance. Furthermore, the time zone differential tends to turn the program into a dual shift effort—one in Seattle and one in Munich—with all the advantages and disadvantages that would logically ensue. The problem of one shift can be worked overnight by the

other, but on the other hand this creates a severe deadline constraint, as the loss of a whole day for the other side is always hanging over one's head.

#### 4. European Travel

Unfamiliarity in working overseas on a large, complex subcontract management effort such as that involved in the NATO E-3A Program, resulted in Boeing's recognizing several problems and difficulties through trial and error. One such problem concerned travel to the FRG.

Because of unfamiliarity in dealing with German subcontractors, Boeing initially had a tendency to overwhelm them with not only paper, materials and supplies, but with people as well. Being somewhat unsure of communicating the concerns of the total project to foreign counterparts, there is a common tendency to resolve problems of this magnitude and complexity by delegating an inordinate number of people to do the task. Moreover the latter solution becomes particularly tempting for many when this entails travel to Europe.

This overabundance of travel can have a negative affect on foreign subcontractor management in several ways. First, continually seeing new faces and having to deal with the inconvenience of educating each new person as they arrive is an annoyance. Repeated visits by a smaller number of people are preferred because a certain measure of confidence in those individuals' abilities can be acquired. Hence, they are understandably uncomfortable if unfamiliar faces continually appear.

Second, they have fewer people in their organization and to significantly outnumber them is to overwhelm them. In several cases they have one or two man groups which represent a total function; whereas, Boeing has perhaps 50 people in a given group. They don't have staff groups as we know them; the staff function is scattered throughout their technical disciplines. For example their Materials and Processes Group may encompass one person for the entire program. This creates difficulties, and the German subcontractors could not understand the necessity for sending over such large numbers of people. It should also be noted that some problems cannot be worked on-site from a visitation standpoint.

Third, the foreign subcontractors obviously have a job to do and a large number of visitors forces them to take valuable time away from their duties, to assist whoever is visiting. The subcontractor would sooner have some of us remain home, leaving them free to produce their product with a minimum of intervention. They realize, of course, that certain visitations are necessary to help facilitate timely production and performance.

Lastly, unfulfilled promises are occasionally made which leads the IC subcontractor to question the integrity and purpose behind these profuse visitations.

Positive steps were taken to control indiscriminate European travel. Subcontract Management needs to be the focal point in controlling excessive travel. There should also be a resident team counterpart that can work many of the

daily problems and to receive necessary guidance by telephone or telex when the situation warrants it.

There was a need to inform and make clear to the foreign subcontractor that the resident personnel were going to be on site for a long period of time, and that the problem of new faces arriving on a continual basis would be reduced. This allowed them to become familiar with the Boeing resident team and afforded them the opportunity to work more closely with them, and thereby align themselves with subcontract and project management in Seattle.

This cutback in travel was, of course, not reduced to a no visitor status. There obviously needs to be a certain amount of person-to-person contact on any program. It should be done monthly or quarterly, or as fact finding and negotiations require. The visiting teams should be small and structured to include a judicious mix of management and the working level people directly associated with the specific issues concerned. On the one hand there is the danger of allowing visitation to degenerate into a game of musical chairs. On the other, as a matter of efficiency the working level people need to interact directly. The problems associated with getting a job done through multiple intermediaries, and in the face of excessive management 'interest' when the need for a trip looms can be demoralizing. Reaching an adequate balance on this sensitive issue is no easy matter. The idea is to maintain personal contact, but at a controlled level.

## 5. Summary Comments on Communications

People of any nation will have a sense of pride relative to use of their management systems and naturally are often not receptive to being directed by foreigners to utilize particular systems and techniques. Presentations are of limited value, especially at the worker level, because of inability to rapidly assimilate information presented in English in an abbreviated manner. Technical data communications are difficult and time consuming. This is further aggravated by a documentation gap between U.S. and European companies. Use of acronyms and U.S. slang is met by resistance because of lack of familiarity and understanding. Geographical and time separations compound the communications problems by lengthening the communications process and potential for misunderstanding.

Recognize the need for bi-lingual capability, early, especially at the worker level on-site in Europe where English language capability is limited.

A translation service is not the answer. Bi-lingual language capability by contractor personnel was found necessary in each functional area. Translation of key U.S. instructions and drawing notes used at worker level were found necessary in dealing with IC subcontractors.

Remember:

- Communications differences have a significant impact on working relationships and ultimate program success.

- Language barriers are real. Pride causes the impression of understanding when there is none.
- Familiarize the Europeans with U.S. systems so they can see the benefits but do not force them. And beware of citing references that foreign supplier wouldn't have. Maximize understanding and use of their systems wherever feasible.
- Utilize resident teams to assure understanding. Maximize one-on-one contact to enable questions and problems to be resolved. Provide formal and on-the-job training early, consistent with task; that will provide a sound foundation for technical understanding.
- Careful preparation of correspondence is mandatory to avoid alternative meanings; elimination of acronyms/slang is necessary.
- Use of a judicious mix of telephone/telex/fax/rapid pouch mail for expediting communications and resolution of technical matters was mandatory in the complex, dynamic environment.

#### D. The Socio-Labor Environment and Scheduling

As is common to other U.S. aerospace firms, The Boeing Company has historically regarded schedules as an almost sacred segment of the business. Work around planning is an integral part of the American business mentality; when schedule problems surface, all participating organizations join in to recover precious time and meet schedule delivery requirements. Contractors in other countries however, often look at schedules quite differently. Schedules are sometimes considered as goals; management attitude is totally different from ours, schedules are targets and are not the most significant milestones among total business objectives. Schedule delays were initially experienced as a result of this attitude.

It must be pointed out that the aforementioned attitude is not necessarily common to all German firms. There have been several cases where a German company accepted the scheduling structure of the program and did what was necessary to adhere to the schedule. However, since scheduling as we know it is not the norm, the U.S. prime contractor must remain cognizant of this fact and take the necessary steps to understand the differences that this entails.

When a "schedule importance" attitude was developed early in the subcontractor's program there was greater success in accomplishing schedule adherence.

Many of the problems Boeing faced on a daily basis were related to this widespread foreign labor attitude with regards to schedules. For starters, German

personnel view business and the world of work from a different perspective. They believe in providing a quality product first and foremost, and delivery according to a strict schedule second. Because of this, they are generally more disciplined in their work behavior and consequently structure their personal time more rigidly. German workers attach a great deal of significance to their free time and are usually inflexible to work schedule changes. This affects schedule adherence and impacts milestone completions. Also, because of this schedule adherence attitude they do not understand the necessity for continual overtime to recover impacted schedules.

A second key reason for this foreign labor attitude is the role German government plays and its impact on German businesses and their employees. Law regulates much of German business and has put restrictions on source selection by becoming a major voice in deciding where to put subcontract work. As in the U.S., but maybe more so, the government tries to channel work to the more depressed places. The intent is to upgrade those areas and balance the economic impact the program would have on the country as a whole.

Law also regulates working hours as far as overtime and holidays, etc. are concerned. German law does permit work on weekends and some overtime, but only when advanced notification to the management is made. This needs to be kept in mind when additional work is needed to meet schedules. They enjoy more holidays and they are generally inflexible toward working on those days if at all possible. This again relates to their firm belief in developing a quality product above all else with much less concern being given to scheduling.

As we've seen in programs in other European countries, overtime is regulated, because of an attitude that, if it is required, the management should hire another individual to take up that excess work load, and thereby reduce the incidence of unemployment. There are strict rules concerning hiring and firing to maintain as even a trend in employment as possible - to avoid "peaks and valleys". There are substantial monetary payments made to released employees for an extended period of time, sometimes up to six months. Employees generally remain with the company for a longer period of time.

Because of the two reasons above, Boeing initially encountered some difficulty in maintaining schedule integrity and recovering schedules. German management is very reluctant and sometimes constrained legally, to take action, as Boeing would, concerning scheduling and milestones on the project.

Though aware of the problem, Boeing at times failed to recognize the degree to which this would impact managing the German subcontract. As a result of failing to fully understand their government rules and regulations misunderstandings cropped up which caused Statement of Work changes. These changes in the Statement of Work naturally impacted cost.

It took time to reach a modus vivendi. When in the FRG, one must operate a great deal in the traditional German mode. By working as much as possible through their established methods and systems, Boeing was able to accomplish a greater return more quickly than if they had to convert wholly to our ways of doing business. It enhanced our ability to deal effectively with them and facilitated changes, arriving at a common understanding of requirements more

quickly. A balance needs to be struck between the two methods but the more the U.S. prime contractor can use their approved methods - methods which they already fully understand - the quicker they are able to convert blueprints into manufactured products.

Moreover, Boeing found that it was better to let the Germans ask to see the benefits of its own approach to scheduling and planning, which they did eventually. A "U.S. way is better" attitude to handling these problems will naturally be rejected by them. Basically, a high degree of give and take is called for.

Boeing experienced a great deal of progress on the program as the German subcontractors became more and more accustomed to United States industry, in particular, our methods of operation, and as we continue to learn their methods of operation, to each collectively arrive at the best solutions to the many daily problems we both face.

During program start up in the late 70's Boeing discovered that its European subcontractors were not familiar with U.S. top down milestone scheduling techniques. Complex programs like the E-3A I&CO task require the development and scheduling of successively smaller and smaller sub tasks.

Dornier was an example of a Contractor not familiar with the need for this method of controlling cost and performance. Boeing established an I&CO planning team to perform much of the front end scheduling and program planning, while Dornier was given instruction in programming techniques. Future programs should include recognition that U.S. industry has to be prepared to provide more front end assistance to foreign subcontractors than it typically does for domestic subcontractors.

There being, less schedule discipline and reliance on "build-to-cost", generally, in Europe. German subcontractors did not always establish firm schedules and manage project completion to that schedule. Neither had they worked as often to FFP contracts. Here again they tended, instead, to rely on the skill of their work force, which has a very low turnover (approximately 2% annually) and a very high experience level. This is not sufficient for a complex program like NATO E-3A. Less than full appreciation of this by Boeing led to some serious schedule delays early in the program, which required substantial effort to overcome.

U.S. contractors need to make sure bidders are thoroughly briefed on the approach to schedule management and cost control. Insist on sufficient feedback from subcontractors to be confident they understand the operating rules and need for in-depth planning. As one final comment, regardless of how

confident all parties feel regarding the subcontractor capability to meet a given schedule a good practice is to establish delivery dates with the subcontractor which are, at a minimum 4 month's ahead of need dates. This should be done on the first two or three systems to allow for all start up problems.

#### E. Training

Lack of training and manpower requirements analysis for subcontractor I&CO manpower planning and training led to confusion and turbulence during both the planning phase of training and its conduct. Funds were not programmed to conduct a training requirements study which could have accurately identified personnel needed for the task, and the content of training for each discipline. As a result, there were numerous changes to the quantity and type of personnel who required training, to the training course content and to the schedules. A further complicating factor was dependence for the on-the-job (hands-on) part of training on U.S. AWACS production schedules. Consequently a manpower and training requirements analysis should be performed at the outset of the program, in coordination with U.S. subcontractors.

The cost of training by the subcontractors was not adequately established due to lack of task understanding. The I&CO subcontractor was required to provide familiarization training for all engineers and technicians scheduled for later in-depth training by the contractor. This was part of the "technology transfer" aspect of NATO E-3A. Training materials used by the contractor were to be transferred intact to the subcontractor. Lack of sufficient interface between the prime and subcontractor and the prime contractor's practice of

using engineering and Technical Order (T.O.) data for training materials with minimal use of textual data (which was an unsatisfactory practice with Europeans who were unfamiliar with E-3A subsystems) led to subcontractor underestimating the cost of training. This problem was also compounded by the language barrier that was widespread at the outset of the program.

The prime contractor must assist the subcontractor by providing sufficient data on how it does business so that subcontractor will know the scope of the task. Subcontractors must invest enough time and resources to develop adequate bids. Both groups must recognize the language problem and take appropriate steps to minimize comprehension impacts. Boeing found that by training a cadre of Dornier instructors on basic systems orientation, who could then provide orientations to prospective trainees, Dornier personnel received the basic background needed to be able to absorb course material. This front end activity should be intensified on future programs with improved results.

As mentioned above, the Subcontractor was generally unable to obtain hands-on training in the U.S. using U.S. production equipment because of the anticipated impact on the U.S. production schedule. The training program for subcontractor technicians and engineers required both academic and on-the-job training (OJT). The only aircraft available for hands-on training were U.S. production aircraft. And this had to be on a non-interference basis. Concern over both cost and schedule impact of OJT training of subcontractors on U.S. production aircraft resulted in only token hands on training in Seattle.

In order to offset this shortfall of aircraft usage in the Seattle OJT phase of the training a series of television programs documenting the major steps in the I&CO task were produced, using U.S. production aircraft. These programs were used extensively by Boeing training in the classroom and were shipped to Dornier for further use at Oberpfaffenhofen. Hands-on training in the laboratories in Seattle was followed by a comprehensive OJT program set up at Dornier using the labs (N-1) and the first NATO production aircraft. Additional Boeing personnel were sent to Dornier to instruct. As a result of the total OJT effort personnel were qualified by September 1, 1981 instead of the original date of June 1982.

Also, the fact that foreign national aerospace industries are generally closely knit can offer greater flexibility in obtaining the proper skill levels. An example of the cooperation possible involved the FRG electronics and aerospace industries associations. Both were committed by an agreement with the German government to provide skills to the selected NATO E-3A I&CO contractor. These understandings were established by the German MOD prior to the final contractor selection. Specific skill quantities were identified for each contractor based on the government/industry agreement. Dornier then established separate detail agreements with these companies. These cooperative efforts were valuable in that the MOD's got involved to resolve problems which could not be handled by the contractor alone.

The terms of these agreements provided for the transfer of employees directly to the selected contractor payroll for a period of several years. This approach provided for the advantages associated with direct control as opposed to "loan" of employees, necessary for an effective use/control of people.

This special relationship between industry and government provided solutions to an anticipated startup problem. The use of those relationships should be explored early in the subcontractor selection process on other programs.

F. Hardware Support for the I&CO

Subcontract (CFE, Reallocation and Transportation)

(1) Facilities Requirements

The E-3A has a very unique and specified set of facility requirements which an I&CO subcontractor must understand and implement early in order to support aircraft arrival. The foreign environment complicated the understanding of these requirements.

Boeing provided the I&CO subcontractor with a written set of facility requirements (Appendix 6 of the Statement of Work) and requested that the I&CO subcontractor translate these requirements into a detailed facility plan. A significant period of time was spent by the subcontractor trying to understand the requirements and respond with the detailed plan. From the initial response, it was clear that they could not correlate requirements and complete the facility plan as scheduled without on-site Boeing coordination.

Early Boeing recognition of the need to have qualified personnel in country to work with the I&CO subcontractor averted a problem.

(2) Provisioning of Mission Equipment, Spares, Support Equipment, ST and STE for the I&CO Subcontract

An enormous amount of mission equipment, spares, support equipment, ST, STE and other materials were provided by Boeing to Dornier. These were all listed under Appendix 4 of the SOW. All support equipment ST, STE and materials bought or manufactured by Dornier to support I&CO was authorized by Boeing and listed in SOW Appendix 5.

Administration of contractor and government (NAPMO) furnished property at this remote site required one full-time employee in Seattle in the Materiel I&CO group along with constant support from other functional groups. Chief among these were the equipment accountability group in PP&C and the AGE Design Engineering group. After an initial review by a Boeing Property Administration specialist from Seattle, followed by a number of corrective measures, Boeing approved Dornier's property administration/accountability system. Surveys continued thereafter through contract close out subsequent to the annual submittal of inventory listings by Dornier.

In the interest of reducing cost of the NATO E-3A Systems, an integrated program was designed to include the last nine USAF production aircraft. However, the NATO contract had to assume the cost for acquisition of certain manufacturing spares AGE, tooling, special test equipment, and facilities in the FRG. Unfortunately the ground rules and system for reaching a final disposition of these assets was not adequately covered in the agreements between the US government and NATO. Consequently, reconciling the needs of on-going US based E-3 production and enhancement programs with NATO-Europe spares provisioning/production, and MOB or depot level maintenance has been

problematic. This issue was raised by the contractor and has been in work between the E-3A SPO and NATO for several years but has yet to be fully resolved.

On future foreign sales programs the contractor recommends:

- (1) Inclusion of precise language in the USG/foreign government contract which specifies the usage of the acquired production assets by other USG sponsored contracts. The language should include specific terms and conditions (rental vs no cost), the applicable time period of interest, etc.
- (2) Agreement to final disposition of all facilities and equipment be clearly defined in the US-foreign government contract.
- (3) An option be included in this government-to-government agreement to allow the USG to buy any residual assets in which the foreign customer had a claim at a mutually agreed to depreciated price.
- (4) All affected E-3A contracts comply with and reference specific US-foreign government agreements.

One other point of confusion that arose in the early days of the program involved the STE, AGE, special tools and general purpose test equipment (GPTE) requirements having been contractually frozen prior to review by Engineering. The Dornier I&CO/FATSL equipment requirements were developed from inputs by Engineering, Manufacturing, Test, AGE Design and PP&C. The composite list from the various groups included: (duplicate requirements by different groups).

- (1) Duplicate requirements by different groups.
- (2) Listed same requirement by different P/Ns.

- (3) Listed obsolete P/Ns for maritime configuration.
- (4) Did not account for shared usage.
- (5) Defined responsible group requirements using inputs from other groups.
- (6) Contracts frozen before requirements were coordinated.

The final equipment requirements list was developed by Engineering and approved by Manufacturing. On future programs, recommend Engineering and Manufacturing co-develop the composite equipment list before contract is frozen.

With the provisioning effort required for the establishment of a second source for I&CO came the need for supporting technical data such as operating manuals (T.O.'s) and test procedures. A problem area arose with the AGE used for I&CO not having been supported by adequate test procedures. Extensive troubleshooting and redlining of procedures were required which impacted startup schedules and subcontractor costs.

- (1) AGE was selected in lieu of STE for use in I&CO in Europe in many instances because of its availability as compared to cost and schedule impacts of updating STE designs.
- (2) Direct application of T.O. procedures for the utilization of AGE by USAF blue-suiters supporting the operational aircraft was not always compatible with the requirements of an I&CO task. Boeing test procedures had to be prepared.
- (3) The AGE was not available for test procedure verification of first usage at IC subcontractors.

- (4) IC subcontractor un-prepared for effort and personnel not trained in use of AGE.

This resulted in the need for a "Brute Force" effort by contractor, IC subcontractor and vendors involving trouble-shooting and redlining during first scheduled usage.

On future programs, the Contractor recommends that procedure verification be planned and scheduled to assure complete and timely support and to provide opportunity for adequate training.

The issues associated with smooth transfer of technical data and know-how brings us to the next section.

### (3) Non-availability of purchased and special tools at European subcontractor facilities.

A large quantity of items commonly available in Boeing tool rooms (portable, perishable and special tools) and regularly used by BAC mechanics and technicians were not available in subcontractor's tool inventories. These included various pneumatic tools, American size drills and counter bores, special cutter tools, and Boeing designed tools used in the accomplishment of controlled processes.

Experienced Boeing mechanics on loan to subcontractor facilities identified those tools required. Appropriate quantities of these tools were then loaned from the Boeing assets to the subcontractors. In the future, an assessment

should be made of the subcontractor's need for these items at the outset of a program.

(4) Cost and schedule impact of hardware returned to the U.S. for repair.

Expensive air freight and lengthy flow times for reparable items that could only be repaired in the U.S. are a significant element that must be considered in the provisioning process. There were some instances where transportation costs and downtime due to failed components was greater than the cost of added provisioning.

Investigate the availability of European repair depots to reduce transportation costs and flow time. Use accurate failure rate data in determining provisioning. Consider added provisioning where the analysis of reparable costs indicate that repair produces marginal benefits.

## 5. TRANSFER OF TECHNOLOGY TO GERMAN SUBCONTRACTORS

The efficient transfer of drawings and data to a subcontractor represents an important part of any such second sourcing program; be it for expanded production capacity reasons or the needs to match foreign the competition, obtain market penetration, or meet customer work sharing demands.

Initially, the complexity involved in transferring data and drawings to the FRG was not fully realized. The tasks were not adequately described to the subcontractors, and many of them did not know what to expect and were not prepared to assimilate the data in a timely manner. Further, they were inundated with various unnecessary materials from Boeing. All this material required translation to German. This was a task that sounded simple, but in reality caused many problems and included more time than allocated.

The primary problem stemmed from the fact that Boeing assumed a level of understanding that, in hind site, could not have existed. Then the data itself created problems. Since there is a difference of drafting practices and techniques between our methods and their methods, they were unable to completely understand the drawings. Furthermore, a matter just touched upon in the previous section the STE drawings were incomplete. This gap stemmed from the not unusual problem of the drawings having developed and changed as the pieces of hardware were built; i.e., configuration control problems. It was then difficult to follow the drawing process to build like pieces of hardware. The help Boeing provided to them involved sending more data, manuals, drawings, etc., many of which were not even applicable to the program on which they were to work. The German firms, unused to this volume of

material and overwhelmed at the amount, were unable to effectively sort out and digest the data.

Research was necessary to determine how to efficiently transmit data. Once again, Boeing came to realize the need to use their methods as much as is practical, thereby utilizing an existing proven system to achieve the most effective results. Forcing or inducing the Germans to learn the Boeing way in its strictest sense, would have only inhibited the learning process, prolonging the time necessary to surmount this difficult area of the subcontract effort.

Once that step was taken, many of the other major problems either vanished or their impact was significantly reduced. Boeing had to be careful to send only the necessary information. This allowed the translation of material to be done in the most comprehensive, expeditious manner, further reducing the number of problems and misunderstandings.

There is a need to employ the appropriate technical personnel to present the package under the guidance of the Subcontract Manager. These representatives should make certain potential subcontractors comprehend what the Statement of Work means and what the technical requirements are.

The U.S. contractor must realize the extensive differences between their way of doing things and ours. Then try to benefit from their methods of accomplishing the work and do our best to admit those lessons into the daily routine of developing and managing a subcontract. There must exist a meaningful exchange with a high degree of understanding between both parties

so as to move toward successful completion of the Subcontract Management effort.

The IC subcontractors required far more intensive training than we anticipated. Without the proper amount of research into their methods and capability, Boeing initially did a less than adequate job in supplying the materials needed to start up the foreign subcontractors. Copies of the data package were shipped to them with the assumption that it would be understood. Boeing later realized they required a good deal more training to begin the job. We also needed to conduct more comprehensive training of our own people in order to be better able to teach the subcontractors. Since we relied heavily on the experience of our personnel, we had limited training available as far as foreign subcontracting was concerned, and as a result, were less than fully prepared to deal with the IC subcontractors.

Three primary reasons were given as causes for these problems. One, the language barrier hampered progress. Boeing could have done better in the FRG in terms of understanding what they were trying to say. Consequently, we were unsure as to how they could best receive the data. This directly correlated to the under-estimated need for training requirements for both parties. They were unable to assimilate the technical requirements for the program. What was said was often misinterpreted. Another cause for the stated problems was the afore mentioned European attitude toward scheduling. Since it is different from the American attitude, Boeing at times failed to anticipate the severity of the problem. Though they are more disciplined in many respects, they were not as schedule oriented as Boeing. There strengths and weaknesses

often do not align with our own. Again, misunderstandings need to be anticipated and resolved.

Several solutions were offered. In order to accomplish a successful transfer of technology, both in terms of materials and knowledge, we need to have our personnel on site earlier in the program to insure American/foreign understanding. We need to establish our credibility and work in small groups as much as possible to provide for maximum in comprehension. A second solution was to work with the German subcontractors in reviewing the data package, enabling them to understand the processes from the beginning. Their active participation in Manufacturing Assessment Reviews and Management Reviews is necessary. This allows them to discuss the areas of concern and gives them the opportunity to understand the requirements by explaining the data, while working with them on a step-by-step basis. One of the major positive actions taken on this program was their adoption of Boeing manufacturing planning paper, Integrated Record System Order (IRSO), documents which helped them tremendously in understanding our process procedures, specifications and the orderly approach to completing the task.

Third, there is a need to educate them on our technology in order to enhance their production capabilities. As we taught them our latest technology, they started to gradually appreciate the problems more and understand our methods of operation. Consequently, there were not as many problems as a result of better cooperation of both sides. Then on-the-job training is needed to the fullest extent possible for the purpose of instructing the German engineers and other applicable personnel. This will entail hands-on work experience so they are able to conduct the same work in Germany with more efficiency.

## A. Technical Data

In some cases it was four months after contract award before the IC subcontractors had a complete drawing package for "Build to Print" items. This delay, coupled with shortened delivery schedules, contributed to missing of initial delivery dates.

- (1) Prime contract award was delayed without change in IC subcontractor schedules.
- (2) Engineering was given go-ahead to prepare lists of drawings required (baselines) only after contract go-ahead. There were thousands of drawings involved.
- (3) Printing the drawings in the format necessary was time consuming (many stable base mylars were required).
- (4) Compiling, packaging and shipping task was larger than anticipated.
- (5) All baseline lists were handwritten for at least six months before computerized lists were prepared. Several more months were required to get the lists accurate, complete and maintained up to date after the lists were finally automated.
- (6) The IC subcontractors did not all handle the drawings in the same manner. Some did no translation, others translated every note and process spec. Some did no dimension conversion, others did complete dimension conversion. Some used the parts lists (PL) as is, while one converted them to its automated PL system with assignment of a unique part number (in their company format) for each part on the PL.

The solutions adopted by Boeing were:

- (1) Additional effort needed to be expended by Engineering on site at the subcontractor to compensate for late delivery of data.
- (2) An automated data baseline was prepared facilitating alpha-numeric sorting, copy ordering, identification of working film requirements, and a list of the current revision status to ensure that the subcontractor had, and was using, the latest drawings.
- (3) Drawing package reviews were held at the subcontractor's facility to review his understanding of the drawings as well as the conversion to the subcontractor's drawing system and to some extent, translation in to German and conversion to metric.

On future programs:

- Initiate action at least two months in advance of contract go-ahead to begin identifying the complete drawing package and order the appropriate reproduction.
- Drawing lists should be automated from the start to facilitate sorting and updating.
- Design Engineering support at the subcontractor should be provided to answer the day to day questions as they arise and conduct an on-going drawing package review to preclude widespread erroneous interpretation of the drawings.

Use of a "build-to-print" concept presented challenges to the program. There were problems operating in a European subcontractor environment where documentation is not required to the extent it is on the in the U.S. and particularly the system. Control and accountability also present challenges in this environment.

The "build-to-print" concept requires much more documentation than just drawings -- process specs, Boeing standards, and MIL-SPECS are all required (including references). The interaction U.S. drawing systems, between process specs and planning paper is difficult for foreign contractors to understand. Also, the cost of data maintenance is high. Control of translations and interpretations must be carefully monitored to assure understanding; and fluid drawing revisions cause problems in a European environment, where designs tend to be more stabilized prior to release for production.

The contractor explored differences in IC subcontractor documentation systems with the intent of maximizing use of their existing paper systems wherever practical. Together, Boeing and DRW initiated a "paper caper" to challenge the need for documentation (reports, data, etc.). This on-going effort produced positive results in the volume of reports and data items provided, and contributed to program cost savings.

The resident Boeing Technical and Management Services (BTMS) in the FRG organization initiated careful monitoring of subcontractor control and accountability practices. BTMS also assisted in development of command media (e.g. operating procedures) by the subcontractor, where necessary, in an environment where command media has a low priority.

Certain items to be produced by IC subcontractor required design changes for the new NATO/US Standard configuration (i.e., drawings for the deliverable configuration were not available until 9 months or more after contract award). Certain delivery dates could not be met.

- (1) Certain items to be fabricated by IC subcontractors required new design for NATO. Go-ahead for the system's redesign was given the contractor concurrent with authorization for subcontractor to proceed with the fabrication contract.
- (2) Due to late availability of drawings at the subcontractor (and late identification of parts requirements) schedules for changed items were not met.
- (3) In addition, there were continuing unplanned producibility changes to many of the items as well as routine drawing maintenance which further added to the volume of changed drawings.

To counteract the above:

- (1) Additional engineering effort was provided to identify long lead parts required by the subcontractor.
- 2) Additional on-site contractor engineering support was provided to the subcontractor to identify areas not being changed to allow subcontractor to start on the item prior to complete drawing release.
- (3) Contractor furnished the initial units in cases where subcontractor could not meet schedule (first unit in all cases where hardware manufacturing was involved and second unit in some cases).

On future programs, the contractor recommends:

- Early identification of changed items with emphasis on schedule impact.
- That the prime contractor consider delivering the first unit of all items and have the IC subcontractor begin with second unit even if

no changes are made unless there is considered to be more than adequate schedule slack.

- That the contractor clearly impress on the subcontractor the state of design maturity of all items so that the subcontractor understands the potential for unplanned changes in low production items.

The NATO E-3A program had significant potential for problems in using a U.S. documentation package in a European metric environment. There were: Potential excessive cost with strict conversion; a lack of U.S. familiarity with metrics; and European metric tolerance practices were different from U.S. Metric conversion proved to be essential for communication with European workers. Further, procurement of converted U.S. sizes is not always feasible. Other factors were: Build-to-print concept required inspection to U.S. drawings; and conversion of U.S. drawings led to misinterpretations and errors because of a lack of understanding of U.S. drawing system.

On future programs the contractor recommends:

- (1) Determine conversion factors and tolerance conventions and permit conversion latitude for noncritical dimensions.
- (2) Give meticulous attention to data labeling.
- (3) Provide technical and drafting assistance.
- (4) Procure certain items in U.S., and
- (5) Assure converted drawings and shop instructions are consistent with U.S. drawings.

Few problems were experienced with use of U.S. drawings and documentation in a metric environment by adherence to those practices.

The dissemination and control of Technical Orders (T.O.'s), manuals, written for the US Air Force detailing the 'how to' of operation, maintenance, calibration and so forth of a given system, subsystem or function was another area that involved a substantially greater effort than originally foreseen. In part this was simply a function of the volume involved. Installation drawings and manufacturing planning (IRS0;s) relied heavily on reference's to T.O.s.

The first major problem involved the obtaining those documents that were needed in either the mandatory or reference technical data files at Dornier. These were ordered from the US Air Force by the prime contractor . A baseline document for T.O.'s was drawn up in 1979 by Boeing engineering, but ordering tended to be on an as needed basis over the next several years. T.O.'s must be obtained from the U.S. government. They cannot simply be reproduced by a contractor, or at least only on an exceptional basis, as approved. It often took up to three or four months to obtain these documents in Seattle from the U.S. government for transshipment on to the FRG. Some took even longer in cases where a draft had yet to be officially published.

The effort of keeping T.O.'s up dated also took time. There was no real problem obtaining a revision once the Boeing Seattle I&CO group was on the US government distribution list for revisions per se, (just the requirement for attention to be applied on an on-going basis). However, after a certain number of these revisions (ADRN's) had accumulated, the whole T.O. would be republished. This not too infrequently resulted in the need for another review for foreign disclosure purposes. Other times Dornier actually only needed 2 or 3 pages of a given T.O. totalling several hundred pages to

perform their allotted I&CO, or acceptance test tasks. But the whole T.O. had to be ordered. And then, if a page was missing from among the several hundred or there was a revision somewhere in the T.O., whether or not Dornier really needed the information the prime contractor had to back-up and reorder it.

Now with the completion of I&CO subcontract Dornier is on their own in obtaining technical data; for T.O.'s this involves purchasing the update service directly from the US Air Force.

In hind sight, for next time around purposes, it would have been wiser to (1) recognize the substantial manpower required and (2) order all the documents immediately once the T.O. baseline was established for the specific tasks.

#### B. Technical Assistance

Some of the IC subcontractors had little experience with a program which had the scheduling complexities of NATO E-3A. This created a potential for significant schedule problems.

It was recognized early in the contractual phase that DRW would require initial planning assistance in an "install to print" environment if the program were to be scheduled and manned consistent with program schedules. This was attributed to the fact that all of the documentation to be used was contractor provided and unfamiliar to Dornier, further complicated by problems associated with Dornier developing detail manufacturing internal paper planning for all program tasks in a tight schedule environment.

The contractor established an I&CO planning team to co-develop key subcontractor schedule interfaces and preliminary schedule layouts with Dornier covering all major technical and manufacturing tasks on the program.

DRW was provided, for reference only, Boeing internal manufacturing planning paper (IRSO's) used on the U.S. E-3A core configuration (the first 24 of the USAF's 34 AWACS) program. The I&CO planning team worked with DRW to develop an understanding of this planning paper and minimize creation of new planning paper. This coordinated activity allowed DRW to accomplish only a minimal amount of translation and use most of the planning paper "as furnished" while making it compatible with their existing planning paper practices. The result, combined with aggressive DRW management, has been on schedule or ahead of schedule performance. This process will enable subcontractors to operate independently early in the program.

On site resident teams were necessary because of geographical, time, and language differences, and the need to assist subcontractors.

The "arms length" environment established by geographical and time differences, required the reliance upon the use of resident teams to coordinate and assure understanding of requirement. They also provided a surveillance function for this complex NATO E-3A subcontracted effort.

Contractor found that there were specific actions associated with resident teams that needed to be adhered to if they were to perform successfully. They include:

- Team members must possess needed skills and be highly qualified;

- Get resident teams on board early, during planning phase;
- Maximize resident team member participation early (statement of work preparation, bid package review, source surveys, and negotiations);
- Provide flexibility of resident team assignment time frames -- skill needs may not coincide with early planning;
- Extensive in-country surveys (housing, schools, transportation, etc.) are the key.

Problems resolution by the IC subcontractors during fabrication of subassemblies and I&CO of the aircraft required Boeing drawings changes or Material Review Board (MRB) disposition on site. Problems encountered by the IC subcontractors would have had to be coordinated with Seattle and the resolution (in Seattle) sent to the IC subcontractor with a resultant schedule impact. Fortunately, the potential problem never developed. This was due to Boeing having sent a knowledgeable resident team to Europe with MRB authority to solve problems and release revised engineering on the spot. This practice included measures to assure formal drawing update and accountability in the Boeing drawing system in Seattle.

On future programs, the contractor recommends implementing the same philosophy. What could have potentially been a schedule impact was avoided, and NATO-1 was delivered ahead of schedule.

## C. Compatability of Materials, Parts, and Processes

Drawings required for IC produced items were initially prepared for fabrication by Boeing using US materials, company unique processes and parts that are often difficult to obtain even by companies in the United States. This is not an uncommon problem for any offloading for outside production purposes of work previously done in-house. The IC subcontractors consquently had trouble complying with the drawings as provided, and design changes were requested by the subcontractor.

- (1) Contractor unique processes specify major equipment items as well as some materials that are not available at the subcontractor facility and are not feasible to obtain.
- (2) Some parts can be formed or fabricated by an acceptable means other than that specified on the drawing.
- (3) Some parts can no longer be procured or cannot be procured in small quantities.
- (4) Cost of procurement from a US supplier may be excessive when a Deutsche Industrie Normen (DIN) Spec part will satisfy the requirement (e.g., hook-up wire for AGE and STE).
- (5) Changes for a variety of reasons including subcontractor convenience, subcontractor necessity and cost were submitted. In some cases the requests were rejected causing hardship and extra cost.

Corrective action taken was as follows:

- (1) All requests were reviewed and dispositioned. Some changes were cost bearing requiring supplier change proposals whereas others handled by a simple single page written request.
  - (2) The changes involved both drawings and process specifications requiring release of drawings changes and process spec departures (PSD's) to maintain configuration control.
- For STE, a substitution document was used instead of individual drawings changes.

On future programs, the Contractor recommends:

- Realizing early that changes will be requested and required.
- Set up a system for change requests whereby part options and other non-complex cost bearing changes do not require a Supplier Change Proposal.
- Respond quickly to requests but consider the following:
  - Contractor furnish the item in lieu of drawing change.
  - Requalification may be a consequence of a change.
- Keep an open mind to options that do not affect qualification status. The requested change could be the one thing that enables costs to be minimized and/or schedules to be met.

The "build-to-print" concept on NATO E-3A required European subcontractor procurement of raw materials, standards, and vendor items per U.S. specifications, usually from U.S. suppliers, causing unique procurement problems.

U.S. suppliers are often not interested in selling small quantities of material to foreign subcontractors in a low rate production environment like NATO E-3A. Moreover, U.S. suppliers often have "export" divisions or foreign representatives who are not familiar with the domestic side of the business. The foreign suppliers for their part had problems in working through their U.S. procurement agents. Adding to these problems are the long lines of communication which exist from foreign subcontractors to U.S. suppliers and lack of leverage by the European firms.

Boeing assisted IC subcontractors by contacting U.S. suppliers. Boeing used its procurement leverage to obtain economic lot quantity buys, schedule need dates and commitments to supply.

On future programs, the contractor recommends:

- (1) Relax "build-to-print" concept. Establish equivalency of foreign specifications where practicable.
- (2) Baseline drawings early and enforce strict adherence to configuration control disciplines by subcontractors.
- (3) At time of drawing preparation, recognize the need for foreign manufacture.
- (4) Early involvement by prime contractor engineering organizations.

Large companies, such as Boeing consider certain standard parts such as rivets to be shop stock items (termed SOP (Sets of Parts) distribution standards) and do not identify these items in the drawing parts lists. The I & CO subcontractor did not have this same shop stock and did not recognize

parts list and reach agreement as to how they should be handled (i.e., identified, priced, procured) early in the contract award phase.

- Provide a copy of the Indentured Parts List (IPL) for each assembly to the potential supplies.
- Prime contractor consider identifying shop distribution standards and assume responsibility for furnishing them to preclude late identification and schedule impacts.

European subcontractors treatment of materials and processes being different from the U.S., the differences had to be recognized.

- Materials European specifications define materials essentially the same as U.S. materials but may have different requirements, e.g., QA requirements are often not included as in U.S. military specifications. European subcontractors typically rely on vendor certification and conduct minimal in-house testing.
- Processes Established European processes generally meet U.S. standards. Processing methods/facilities may be equal. However, manufacturing processing, documented tests, or qualification data to validate processes often is not available (reliability, corrosion, etc.). Again this is due to the greater reliance in Europe on skilled workmanship rather than specification control to obtain disciplined

the requirements during the proposal nor in time to support initial deliveries.

- (1) The requirement for part type (such as rivet family and diameter) are identified on the drawing but the total quantity and specific length are not shown based on the fact that this contractor's shops have stocks of all sizes which are maintained at some minimum level.
- (2) The subcontractor did not recognize all the requirements and even then was reluctant to order a full range of sizes not knowing if all sizes were required and what the quantity of required sizes would be.

Resolution included:

- (1) Prime contractor providing the IC subcontractor with estimated shop stock lists in order that procurement could be initiated to support schedules.
- (2) In addition, prime contractor provided initial quantities of many late identified items in order to preserve schedules.
- (3) Subcontractor identified usage by part on initial units in order to maintain stock at adequate levels for remainder of contract.

On future programs, the contractor recommends:

- Clearly pointing out to IC subcontractors during proposal phase that certain items such as rivets, electrical splices and terminals, cable clamps, fasteners, etc. may not be fully identified in the

quality. Often quality acceptance criteria detail is lacking.

On NATO E-3A, Boeing resorted to the following solutions:

- Repetitive reviews conducted by the prime contractor Quality Assurance (QA) personnel on process specifications including demonstration of process techniques.
- Materials procured primarily from U.S. suppliers with limited item by item authorization to use substitutes.
- Subcontractor process specifications reviewed in detail by contractor engineering, QA, and manufacturing planning at drawing package review.
- The prime contractor provided items (CFE) as requested by subcontractors.

In the future, a materials equivalency document effective at the program level will be used to alleviate some of the problems experienced with NATO and should significantly reduce the magnitude of this problem.

The "Build-to-Print" subcontracted electrical items, including supporting STE, caused unique fabrication, procurement and drawing problems.

- (1) In many cases, Boeing had only built one of a kind for a given piece of STE. There were producibility problems due to: a) the manner in which drawings are prepared (i.e., in parallel or subsequent to unit completion), b) age of the design and type of parts used (i.e.,

commercial) many parts are no longer procurable or not procurable in small quantities.

- (2) German Safety Standards required redesign for such items as power cords, fuses, outlets and front panel components with metal parts such as switch handles.
- (3) To save time and money, the subcontractor preferred to substitute certain DIN spec components for those required by drawing.

Boeing was able to resolve the problems by:

- (1) Providing on site design support to identify corrective actions and to review and approve requested component changes.
- (2) Establishing a substitution document limited to STE thereby rapidly responding to requests from the subcontractor by changing one document instead of numerous drawings. (A typical request would be substituting a DIN spec family of capacitors for the family type(s) required by the drawing).
- (3) Establishing a simple written form for requesting changes in lieu of individual SCPs. The one page form identified the requested change and included a space for contractor comments/approval. (Approximately 500 requests were processed at one subcontractor.)

On future programs, the contractor recommends:

- Early involvement by contractor and subcontractor engineering organizations to understand and coordinate unique procurement/production/safety problems and determine proper course of action.

- Relax enforcement of identical parts requirement allowing the subcontractor to propose producibility and procurement substitutes (which of course, must be documented). The prime concern for STE is "functionally identical."
- Allow subcontractor to design and build functionally equivalent STE items on a selected basis.

The "build-to-print" concept on NATO E-3A required IC subcontractors to use process specs that were different than those used by the subcontractor.

Drawings for the E-3A hardware imposed process specs on IC subcontractor that were unfamiliar to them. Compliance with some of these requirement would have involved considerable cost to the subcontractor and program.

In many cases the IC subcontractor was using processes and process controls that were equivalent to those specified by the drawing. The prime contractor reviewed alternate process and permitted their use if they were equivalent or better. On future programs the contractor recommends early involvement by contractor and subcontractor engineering organizations to resolve questions of equivalency.

More processes had to be translated than were necessary for the NATO E-3A because there was no process-to-drawing cross reference.

In Boeing normal production for U.S. programs, little benefit would be derived from being the normal drawing release procedure identify and tabulate the

process used on each drawing. Since the processes for the NATO E-3A could not be identified, it was necessary to translate all processes.

For future Industrial Collaboration programs, consideration should be given to process identification at the time of drawing release or revision.

## 6.0 Gimlin and Standlee's Summary Comments on Their BTMS Experience as Materiel Reps at The IC's.

### A. Source Surveys of Potential Subcontractors

1. The Source Surveys that were performed on the NATO E-3A program were evidently not conducted in adequate depth. Not enough factual information was obtained to allow identification and scoping of the potential problems that subsequently were encountered by the resident teams and subcontractors.
2. On future Source Surveys, a detailed plan should be established which forces Boeing to make an in-depth review. It should be in enough detail to allow factual comparison between all necessary contract requirements versus the subcontractors ability to satisfy them. This will force an identification of the subcontractors shortcomings and allow for better planning by the resident teams and the subcontractors.
3. The Source Survey Plan should cover at a minimum the following areas:
  - a. Review of drawing system and how it is used vs. what the prime contractor plans to supply on its drawings.
  - b. Shop stock capabilities vs. prime contractor method.
  - c. Manufacturing and Production Planning Paper System.
  - d. Configuration Management System vs. typical prime contractor requirements.

- e. Manufacturing capability vs. the items to be produced.
  - f. Process specifications vs. prime contractor imposed specifications.
  - g. Procurement System as it would relate to buying from the U.S.
  - h. Reporting System and tracking of manufacturing process, etc.
  - i. Review of Government unique rules and regulations that could be different from the U.S. and how they would effect production of hardware.
  - j. Review of different power sources and related connectors, cables, etc.
  - k. Manufacturing capability vs. what they might have to sub-contract (BIG area of concern).
  - l. Review of company unique work hours, multi shift capability, vacations, etc.
  - m. Management structure and how it would relate to Boeing requirements.
  - n. Quality System, is it strong enough for control of make and buy items both? Can they handle nonconformances, Material Review Boards (MRB's) corrective actions, First Article Inspection (FAI's), etc.
4. The Source Surveys should be conducted by personnel who, to the greatest extent possible, will be members of the resident team, and have to live with their selection to make the program go. This more than anything should make for an objective selection.

## B. Bid Package Preparation

1. In most cases the Bid Packages presented to the NATO subcontractors were not complete, accurate and most important, not reviewed and explained in detail to the bidders. It appears now (after the fact) that none of the subcontractors comprehended the content, complexity, and magnitude of their respective statements of work. Compounding this problem has been all of the corrections required due to errors in the Boeing drawings and other documents. This was a big problem with the STE and Tooling packages.
2. It would appear that there are two alternatives that a prime contractor has when it knows, and will admit, that its Bid Package is incomplete and/or subject to many changes:
  - a. A two phase procurement wherein the contractors are authorized to proceed, with the first six months to a year being a contract definition phase. This will allow for a complete clean up of the statement-of-work and for the subcontractor to gain a realistic assessment of what the job will cost. After this period of time a firm contract could be negotiated for the total job with equity for all parties.

When a subcontractor has negotiated a contract at what turns out to be too low a value from day one, it is hard

to get them motivated to add more capability. This forces the prime contractor to throw in additional man power.

b. The second choice would be to be straight forward with the subcontractors and provide them with a functional briefing in detail for each area of the Bid Package. This briefing should cover at a minimum the following:

1. Type of management structure the prime contractor feels will be required to get the job done.
2. Condition and completeness of the prime contractor's drawings, specifications, etc. and explain how to use and cross reference from drawings to specifications.

Boeing, in the future, should consider creating a clean drawing file on each piece of hardware. This file would delete non-required information from drawings for each IC. It would be reviewed for its true capability of producing the required hardware. This would be a second set of drawings for NATO only.

A thorough review of the drawings package should be made of non-qualified (STE) items prior to their submittal for manufacturing. In areas where tooling drawings are utilized, every attempt should be made to authorize European basic materials.

Engineering equivalency documentation presently existing in NATO identifies equivalent materials/parts that have been established on previous NATO programs. Since no failure from the European manufactured hardware would be catastrophic to the E-3A program, I recommend that the following be established on any future program.

Basic contract between Boeing and USAF be revised by ECP to allow unilateral substitution of these equivalent materials without drawing change.

Each IC subcontractor would be required to document where the equivalent materials were used and that its equivalency was established prior to the start of the program.

3. Configuration Management requirements should be explained in great detail with examples to emphasize the need for this in proving the 'as built' condition and for delivery paper.
4. Planning and schedule tracking requirements of Boeing were not explained or understood by the German contractors. It was a completely new concept to them. The contractor should explain in great detail, utilizing actual examples,

showing how these are generated and used as management tools to provide greater visibility.

5. Review with the foreign subcontractors the need for a good procurement plan, taking into consideration using a buying agent for items bought in the U.S. lead times, flow down purchase order requirements (COFC, Government Source Inspection, receiving inspection etc.)

Also the firm requirement for a procurement follow-up system. Most of the German contractors did not have a follow-up system and were not aware parts were going to be late until the delivery date has passed.

Review of applicable material and process specifications well in advance of production is mandatory if all the necessary materials, tools, equipment, training and certifications required therein are to be available on time. Experience has shown that a joint review with BTMS leading the IC subcontractor through the first stages at least, is most efficient and allows BTMS to explain the system to the IC subcontractor. In one case where BTMS was not allowed to assist, the reviews either were not accomplished at all or were too late to be of use, or were poorly done. The case in point resulted in hardware rejection, schedule delays, and the need for many last minute changes.

Following is an outline of the procedure that has been most effective to-date. It is recommended that one not bypass a system of this level of detail in favor of a simpler one that must rely on a thorough knowledge of the weapon system, rather than drawing analysis, to decide whether or not certain specification requirements are applicable. When the latter has been done a higher percentage of items were missed requiring changes later which would not have been necessary.

#### Examine each drawing

- List BAC specifications, procedure documents and finish codes. These are to be found in the parts list (P/L) in the drawing notes and sometimes in the body of the drawing.
- Decode the finish codes and list the process specifications, Government specifications, etc.
- List materials specifications and materials shown on the drawing.
- Analyze each of the above listed specifications etc. with respect to the task to be performed for each drawing. Mark a copy of each specification with colored highlight pens to indicate applicable para-

graphs and to indicate, in the text, where materials and the next tier specifications are called out.

- Record the next tier specifications.
- List materials and estimate quantities. Provide to the IC subcontractor's procurement department.
- Repeat the above process for each of the 2nd tier specifications or documents. Examine only the portions called out in the first tier specifications or document.
- Repeat for the 3rd and 4th tiers, further if necessary.
- During the analysis of each process specifications, pay particular attention to those requirements pertaining to:
  - Training of personnel
  - Certification of personnel, equipment, and tools
  - Procedures, equipment, and tools not compatible with the laws of the country

- Submission of process specifications or other documents for approval

During analysis of each material specification, highlight the subcontractor's quality assurance responsibilities.

Prepare PSD's, PDD's, ADRN's, or ADCN's as required to resolve problems or reduce program costs.

The following problems have occurred in Europe much more frequently than in the USA.

- Material or part number from the Qualified Products List (QPL) is entered on the P.O. without reference to the specification.
- Material is ordered from a non-QPL source or an unlisted division or plant of a QPL source.
- Material is ordered from an agent who orders from an unqualified source.
- Material is received improperly marked.
- The supplier makes unauthorized substitutions.
- The supplier sends free samples without appropriate specification control rather than bother with small quantity orders.

The reasons for the above appear to be the unfamiliarity of the European purchasers and suppliers with the U.S. Government and BAC specification systems. The agents in

the U.S. through which the IC subcontractors buy U.S. materials have been responsible for much of the problem because they seem even less familiar with the specifications than the foreign IC subcontractors.

To forestall these problems in the future, each I.C. purchasing agent should be briefed on the problems and their effects on costs and schedule delays. As a minimum they should be instructed to note on their P.O.'s that only qualified materials from the specific qualified sources are acceptable, that no unauthorized substitutions shall be made, that the materials must be marked per the specification, and that required certifications must be furnished.

Many IC subcontractor purchasing people do not explore the various alternatives open to them when they encounter a procurement problem such as:

- Material no longer manufactured
- Quantity too small, manufacturer will not supply
- Delivery time too long
- No readily apparent domestic source

The IC subcontractors frequently contact only one source and, if it is from a QPL, it is often the first on the list. If they were taught to contact several sources at

the same time or at least contact the one from whom Boeing buys they may avoid long delays.

Because the quantities purchased by the IC subcontractors are much smaller than those purchased by the prime contractor it may be best to encourage ordering of materials from the prime. At least it would be advisable to obtain a quotation at the same time as the RFQ's are sent to other suppliers.

Most of the I.C.'s so far have not demonstrated an ability to locate domestic sources of materials. They should be told of ways to find sources such as:

- Telephone contacts with companies selling related products. A fiberglass distributor can lead one to a reinforced plastic manufacturer or a paint supplier can tell one where to buy solvents if he doesn't sell them himself.
- Use of the telephone book yellow pages.
- Use of directories such as "Europe Production".
- Contacting U.S. companies by telex to find names and addresses of the nearest plant or distributor.

6. Data and SDRL requirements were not understood by the subcontractors. These should also be explained in detail

with examples. In the majority of cases the resident teams have actually prepared most of the data items for the subcontractors. Some of the I.C. have stated "had they known the amount of paper required for this program they probably would not have proposed the job or would have at least priced in alot more money for this effort".

7. Manufacturing functionals should review all manufacturing records for each item, and identify the areas where the U.S. firm had manufacturing problems. These should be documented and supplied to each IC subcontractor. This would prevent the IC's from having to go through the same learning process.

It is evident now, for example, that Dornier did not comprehend the content, complexity, and magnitude of the I&CO task as result of the initial evaluation of the original statement of work. This manifested itself in poor initial planning because the task was not understood and very late contract agreement because of the need for extensive fact finding.

The solution to prevent recurrence in the future would be a thorough technical transfer provided by prime contractor personnel who were directly involved in accomplishing the task in-house. This would provide the selected IC subcontractor with a far better understanding, even if all

technical data were available, on which to develop a sound proposal.

In summary the U.S. contractor should take the time and spend the necessary effort to assure itself that potential subcontractors truly understand the total Bid Package requirements and company idiosyncracies .

C. Sub-Contract Award

During the negotiations and contract award process very detailed discussions should take place to make sure, because of language differences, if for no other reasons, that there is a complete understanding and meeting of the minds. Contracting has to be more specific, needs to make fewer assumptions and needs to be prefaced by more study on the part of Boeing functionals who dream up this contractual language.

1. Identify each measurable milestone required to be met and the payment to be based on these milestones (such as delivery, process capabilities, tooling, etc.)
2. What hardware they are to build and to the specific revision status.
3. Identify delivery dates required on each piece of hardware, taking in to consideration excess time on the first few units.

4. Identify documentation required by the prime contractor from the IC subcontractors. Each of these would be individually discussed and a prime/subcontractor agreement made as to what each requires including forms, data etc.

- Detail term and condition requirements.
- Paper for delivery.
- Manufacturing paper required.
- Tooling requirements.
- Shop stock required (rivets, etc.).
- SDRL Requirements.
- In country processing of changes.
- MRB capabilities.
- SCP processing.
- Change processing methods and commitments.
- In country support requirements.

5. Require use of Boeing drawings exclusively.

6. Specifically identify to each IC the true meaning of "Built to Print".

That is: Prime contractor specification to be used as called out. Materials called out are to be used.  
Materials/parts to be procured from qualified sources, etc.

7. Within the Q.A. organization we need to practice what we are preaching, namely better and more specific contract language on treatment of nonconformances with emphasis on getting them written.

For example, it must be clear that, nonconforming material must first be rejected, and that MRB decisions will govern decisions as to continuing production with nonconforming material.

8. Where we use boiler plate language to talk about inspection rights, we must expand to indicate that those rights are partly in the interest of assistance and, of course, particularly in the interest of accepting hardware. It should be also emphasized that impediments established by the subcontractor will not be allowed.
9. Our statements regarding corrective action must be expanded to indicate what we mean. That is, what will be done to correct the problem on future items by unit or date, who is responsible for confirming that the corrective action commitment is met and how those responsibilities are to be properly executed.
10. In the case of AEG-Telefunken, Boeing had no idea that the contract would be spread over such a range of second and third tier subcontractors. This may indicate an inadequate investigative and interrogatory process on the front end. A

large share of the Q.A. support requirement of Seattle results from unbridled subcontracting.

11. In the interests of economy, AEG-Telefunken was exempted from the requirement to produce a configuration management plan as a data item. The money saved and put in a small purse was over balanced many times by the unnecessary funds extracted from the other pocket. Any subcontractor that is going to produce a somewhat complex item with the possibility of changes occurring should have to submit for approval a configuration management plan before production starts, unless he has a suitable track record with the prime contractor.
12. A key member of the Boeing resident team should be involved in the negotiations as in the Source Survey efforts to assure necessary consistency and follow-through to the Production Phase of the program.

## 7.0 OPERATION AND SUPPORT OF THE NATO AEW & C FORCE

### A. The Establishment of the NATO Force

One of the most noteworthy aspects of the NATO E-3A program is that NATO, not the member state Air Forces, is the actual owner of the system. For this system NATO set up a new command, the NATO Airborne Early Warning (AEW) Force Command, located at Maisiers, Belgium, adjacent to SHAPE. Though the NAEW Force comes under the operational command of the three Major NATO Commanders (Tri-MNC)-Saceur, Saclant, and Cinchan—it is Saceur which acts as Executive Agent on behalf of all three.

The first commander of the NATO AEW Force was U.S. Air Force Maj. Gen. Leighton Palmerton, 1980-84. Palmerton was succeeded by Luftwaffe Brigadier General Klaus W. Rimmek who had been the first E-3A component commander (since January 1981). At the E-3A component Rimmek was himself replaced by USAF Brigadier General Hugh L. Cox III. The NAEW Force and E-3A component commander positions are rotationed between the FRG and the US.

The Force Command is composed of 18 E-3A aircraft based at Geilenkirchen along with 11 NIMROD Mark III aircraft that will be based at Waddington Royal Air Base in the United Kingdom. Unlike the E-3A Component, the United Kingdom's NIMROD Component will remain a British military resource (though operationally controlled by NATO).

Both Components will have Forward Operating Bases (FOB's) or locations. The E-3A Components's FOB's are located in Greece, Italy and Turkey and their FOL

is located in Norway. The NATO AEW Force began regular deployments to its first forward operating base in Konya, Turkey, in the fall of 1983.

Delivery of the E-3A's to NATO began in 1982 with the final aircraft being turned over in April 1985, two months ahead of schedule and under budget. The first production versions of the British Aerospace Nimrod Mk. 3 airborne early warning aircraft were scheduled originally to join the NATO force by the end of 1983, but now the soonest date is 1986.

#### 1. The E-3A Component

The E-3A Component graduated the first international crew in December 1982, and had achieved a 96% readiness rate as of the following spring. By the end of 1983 training progressed to the point that the first fully operational squadron of six E-3A aircraft was activated. The second squadron was operational by the end of 1984, and the third and final squadron by mid-1985.

Despite the progress, NATO AEW officials were originally concerned that too much may be expected of the force. In an interview with Aviation Week\* published in its April 4, 1983 issue: Maj. Gen Leighton R. Palmerton, then NATO AEW Force Commander, said,

There is a tendency for people to assume we are a mature organization, but we are not. Any other time when someone fields an all-new weapons system, they have a basic military structure to fall back on. But we are introducing a new weapons system without a basic structure. We're having to invent it all. I think we'll have some more growing pains. What we've done here should serve to provide models for any other NATO command that may be set up, making it easier to organize future commands.

On the other hand, NATO AEW officials have said the ability to design their own rules on many subjects has contributed to the unit's success because the rules could be tailored to particular circumstances. "We have been able to pick out the best things from each country's military and incorporate it into

our system," Italian air force Col. Pietro Fronzoni, commander of the training center, said.

The new rules also contributed initially to morale because they are well tailored to the unit's needs, and because the people who were working under the rules usually had a hand in developing them.

"There is a pioneer spirit here right now," German air force Lt. Col. Rainer Lammering, chief of military personnel, said. "But that pioneer spirit gradually will end as new people, who have not had a hand in making the rules, begin to arrive."

The rate of unit growth was reportedly a problem. Total personnel in the E-3A component increased from 63 in 1980 to 736 in 1981 to 1,539 in 1982. The figure was expected to reach about 2,200 by 1985. The sheer volume of arrivals often strained the ability of the small air base on the German-Dutch border to process personnel and provide needed facilities, as well as the surrounding community to provide housing. At the same time, the base itself had to be modernized. A new 10,000-foot runway, aprons and taxiways were built. Two of the four existing hangars were refurbished and extended.

Most of the base activity at first involved training. National personnel generally arrived well qualified, but had to undergo an average of 4.5 months each of additional training in order to transition to the E-3A equipment.

The AEW force has been placed under the direct control of NATO in peacetime. Other forces, including those procured as part of other NATO projects, are

under the command of national authorities in peacetime and therefore use the national logistics structures as well as codes, regulations and procedures.

As NATO lacked a structure similar to the U.S. Air Force Logistics Command, (AFLC) a new organization was devised. In the past, national troops were assigned only to staff positions in NATO headquarters, so logistics were provided by the national governments. The alliance now had to develop a logistics and support system for the command.

The NATO AEW force also has unusual problems because it is made up of military personnel of all ranks from 11 nations with different native languages and varying skill levels and procedures.

The AEW force has had to develop an international manual for flight safety. NATO did not previously have one because the national air forces flew under direction of their own manuals. The resulting NATO AEW manual was based loosely on the Canadian flight safety manual.

AEW officials decided that the solution to the language problem was to standardize on one of NATO's two languages, English, for use in the AEW force. Given, there is a certain logic to this as the system is of U.S. origin and the U.S. is the largest funding nation. Personnel assigned to the force are required to be proficient in English. Brush-up courses are offered.

## 2. The Nimrod Component

The Janes Defense Weekly of February 23, 1985 announced that the Nimrod would be in service by 1987. Eight royal Air Force Nimrod AEW aircraft should be in

service although no decisions has been taken on when a further three aircraft involved in development work would be upgraded to operational standards.

One of the three aircraft was considered likely to be used for long-term development of AEW and as a source of spares.

Air Chief Marshall Sir John Rogers, Controller of Aircraft had confirmed the previous week that the Nimrod program would be four years late and would meet only an interim standard.

The MoD has spent 816 million on Nimrod AEW, and another 189 million was still committed. It was assessed that not even this amount would be sufficient to equip all the aircraft to the required standard. Upgrading the development Nimrods will need additional cash. The Air chief Marshall indicated that, for cost reasons, the RAF may opt for some deficiencies rather than bear the cost of the full standard.

#### B. Start-up Problems at the MOB: An Industrial Perspective

##### 1. Manpower Planning

For starters late manpower planning brought on by budget limitations, an over-taxed staff, and long approval cycles led initially to inadequate manning of the E-3A Component's maintenance wing at Geilenkirechen.

To reduce O&S costs by hiring at low salaries and by maintaining a low personnel turnover rate, a plan was developed well after program go ahead to man about half of the MOB maintenance wing positions with local wage rate (LWR) personnel. This would have involved, however, a significantly lower

salary rate than required to induce qualified applicants to hire on. After this approach had been tried for about one year with limited success, the LWR positions were converted to NATO "C" grades with better pay and benefits. Although this change affected the number of candidates for technical positions, it was too late for candidates to meet E-3A unique training schedules. The result was a major shortfall of personnel who would have completed academic training and been available to start hands-on training by the start of 1982.

Early planning and more complete staffing would have allowed testing plans with employment surveys before choosing a final approach. Also, shorter decision cycles would have alleviated this problem significantly.

## 2. Training

Qualification of European IC subcontractor candidates for Contractor Maintenance Support (CMS) was made very difficult by experience and training restrictions.

The SOW for Contractor Maintenance Support contained impractical experience criteria for CMS technicians and did not allow for the cost of training European IC candidates, but did allow for the cost of training U.S. personnel. This problem created a great deal of difficulty in finding sufficiently qualified European IC personnel who could meet NATO's criteria. Also negotiation of the contract was more difficult because the cost of training was disallowed. At least two candidates were lost due to these problems.

A NATO customer should recognize the likelihood that training will be required during IC Contractor Maintenance programs, and reach a compromise with participating industries that will balance experience and training to achieve mutually acceptable goals.

Training equipment and some academic training was not procured due to a program fund shortage and lack of a training requirements analysis to justify the need for the equipment and the training.

When the need arose to "descope" the acquisition program due to a general funds shortage, some training and all training equipment (e.g. the CAE GmbH maintenance trainer) was eliminated for maintenance technicians. Since no training requirements analysis had been performed, only cursory data was available to defend the need for the equipment and the training. The result was a cutback which will affect maintenance training and maintenance by the Component Command. A thorough training requirements analysis should have been performed at the outset of the program, one designed to determine training and equipment requirements, and establish a basis of justification for funds expenditure.

The NATO E-3 Component Command had to train maintenance personnel using aircraft instead of maintenance training equipment, and had to start operations with a significant personnel shortfall. The E-3A is a complex system which requires more than superficial knowledge to plan and program a major operational force. The small planning staff assigned to NAPMA at the outset of operational phase development was not greatly experienced in the E-3 system. The combination of a small, inexperienced staff bound by tight budget

restrictions, led to development of a manpower plan that was incomplete and could not be defended against budget cuts. In addition, concept development for each functional area was substantially delayed.

In combination with other factors beyond control of the planners, lack of experience is seen as a significant factor for less than desirable manpower levels in maintenance and training, no training requirement analysis, late hiring of civilian workforce, and late release of concept plans necessary to plan and activate the Component Command. The responsible acquisition agency should have been provided with enough planners experienced in each functional area of the weapon system. It's advised that training requirements analysis be prepared and concept plans developed as early as possible.

### 3. Technical Orders and Manuals

Then there was a lack of timely data at the training or operational unit for establishing shops and training programs. Technical Orders (T.O.'s) and flight manuals were formally released 60 days before the first aircraft was scheduled to be delivered to the operational unit. Long before data delivery, training was required for a cadre of personnel, and the operational unit was required to set up shops and prepare a training program. Consequently, T.O. and flight manual development planning is needed to support cadre training, and be available for early use at the operational unit. This is a primary consideration for all future T.O. development required on E-3 programs.

Integration of NATO E-3A coverage into existing USAF T.O.s initially caused a major problem within TAC and AFLC. AFLC and TAC have not accepted the Air

Force decision to procure integrated US-NATO Standard T.O.s because of anticipated useability problems (concern that NATO changes will get into US T.O.s, and discloseability) and potential contracting problems. Significant cost and schedule impact would result from redirection in T.O. repackaging.

It is necessary to ensure that deviations from standard T.O procurement practices are fully coordinated and agreed to by all parties involved.

#### 4. Spares Provisioning

Organizational and Intermediate (O&I) level spares were not funded at the same time that the DT&E/production contract go-ahead was received. That decision initially resulted in a non support situation for nearly 400 spares due to long lead times.

At the time of the spares contract award there were already over 400 items past lead time for procurement many of which were identified as critical to operational support. This number then grew to over 1250 items. This problem required substantial extra procurement effort involving unplanned manpower to negotiate acceptable delivery dates. The result of late funding is that about 400 items were not delivered in time for first aircraft arrival; 12 of these late deliveries were in the "critical" category.

The award and funding of spares contracts needs to be concurrent with production, since spares frequently have lead times similar to production material.

#### 5. Facilities

Due to the large number of participants in a multi-national program-NAPMA the SPO, the ALC, Boeing and subcontractors-defined areas of responsibility for the development and implementation of specific facility requirements must be established early to insure all requirements are identified and worked.

Maintenance and operation of the aircraft at a Main Operating Base (MOB) is dependent on a fully structured facility. Early MOB activation relied on a number of independent groups establishing these facilities, each working to varying requirements.

It is important to establish working roles early between Boeing, SPO, Agency Civil Engineering, Contractors and Supporting Agencies to allow for the necessary transition of data and the mutual understanding of responsibilities.

### C. NATO DLM Program

A solution to Depot Level Maintenance (DLM) that was acceptable to each nation was not developed early enough to establish a DLM capability in Europe to support initial fleet operations. A satisfactory contracting approach and cost sharing formula could not be coordinated by the management agencies in time to establish a DLM capability by need date. As a result interim support by US depots via NAMSA through FMS channels was resorted to with a concomittant loss, at least initially, of industrial benefits to European industries, and acted to delay agreement up on a MOU for O&S cost sharing until late 1984. In the interim the parties concerned had to work to an unsigned MOU dating from 1981.

A coordinated and agreed to logistics planning document should have been developed with coordinated milestones on key elements. Sufficient staff planning capability to coordinate actions necessary to support major milestones such as establishing a European DLM capability was not provided. National staffing and approval of each major step in the definition of the plan takes time recognizing that individual nations and their contractors will insist on maintenance as well as acquisition roles.

NATO originally intended to use the US Air Force maintenance concept, which provides for organic support of the US E-3A, i.e., including heavy maintenance. From 1980 to 1982 the nations participating in the NATO E-3A program debated and finally agreed upon a Depot Level Maintenance (DLM) concept which provided for the spin-off to industry of the heavy or fourth level maintenance. The maintenance work would be allocated among industrial companies of the participating European nations and Canada at a specific ratio, with the overall contract volume of work being managed by an industrial prime contractor.

In July 1982, NAPMA issued the first edition of a Request for Proposal for the NATO E-3A DLM to a number of companies which had been nominated by the participating nations as prime contractor candidates, including as one might expect Dornier. An essential requirement, and at the same time a considerable impediment to the preparation of the proposal, was the aforementioned allocation of the work among the industries of the participating nations in accordance with Industrial Benefit (IB) Goals.

Meanwhile Dornier had performed a survey of potential European companies in the period from June to August 1981. Dornier found some 45 companies which met the requirements for being selected as subcontractors. However, selection of suitable subcontractors by way of tender was not possible due to the fact that some nations had already charged certain companies within their respective countries with the allocation of the work share claimed by that nation. These designated companies had also been charged with specific work packages.

Since final contract award requires the consent of all participating nations, the objective was to coordinate this work sharing in the best way possible and to prepare a proposal which met the operational requirements of the E-3A Component while allowing for an economically acceptable solution.

Following lengthy preparations a useful work sharing concept was found which satisfied the various, and in part contradictory, requirements to the greatest possible extent.

In August 1983, NAPMA issued a revised Request for Proposal for DLM on a sole source basis to Dornier. Dornier prepared and submitted a DLM proposal the following January with prime contract award expected by mid-1984. Meanwhile in October 1983 the NATO E-3A program reached a significant milestone with the delivery of the ninth of NATO's eighteen aircraft.

Along with this operational growth pressure increased to develop a DLM capability and to implement a work redistribution plan which was aimed at a wider spread of work among the participating nations. While the NATO AEW Force's

E-3A Component at Geilenkirchen (FRG) was expanding its capacity to handle Organizational and Intermediate (O&I) level maintenance responsibilities DLM had to be spun off to European industry. In some cases the Original Equipment Manufacturer (OEMs) would continue to provide maintenance support directly to the NATO Main Operating Base (MOB) through NAMSA contracting channels.

Dornier was preparing a proposal along with several Sources of Repair (SORs) - KLM, Sabena, and Aeritalia - which were to enter the picture as subcontractors for the first time. The proposal was scheduled to be submitted to NAPMO by January 31, 1984.

Though some of the NATO production program's IC subcontractors were to continue in the DLM phase, others were expected to pass their work packages on to non-German firms. As of early 1984 some uncertainty remained as to the ultimate work sharing (industrial benefit, I.B.) arrangements and the rate at which NATO would invest in the establishment of second sources in Europe.

Industrial Benefit (IB) groundrules for DLM were as follows:

- Within the IB groundrules, DRW was to propose the most economic solution.
- Normal prime subcontractor relationship was to be applied, i.e., no consortium type legal framework: DRW was to be prime contractor with AEG-Telefunken, KLM (Netherlands), Sabena (Belgium) and Aeritalia (Italy) as the four major subcontractors.
- Hellenic Aerospace Industry (Greece) was to continue to contract directly with NAPMA until the DLM effort was underway in 1986, at which time Dornier was to compete them against Sabena for the power plant.

- Among the major IC subcontractors for the NATO production program, several were out of the picture because work on their parts of the system was to be transferred to Aeritalia.
- I.B. goal is for NAMS to phase out FMS procurement of maintenance services from the US to as great an extent as investment constraints would permit.
- The other seven participating NATO nations were to receive their share as second tier suppliers.
- Minimal layering of subcontractor hierarchy.
- No duplication of sources.
- T.O.s were to be utilized whenever they existed. Reliance on Original Equipment Manufacturers (OEMs) for other the balance of the documentation was required.
- Incumbent upon designated SORs to work out necessary contractual arrangements with each of the OEMs.

Clearly defined repair work packages will be subcontracted by Dornier to AEG Telefunken, Aeritalia (Venice and Turin), Italtel, KLM, SABENA. Further European/Canadian subcontractors were to be added when the workload increased as expected. Support from the original manufacturer, Boeing, would be secured by means of a Technical Support Agreement. Similar agreements were to be made between the mission avionics manufacturers (OEM's) and the respective repair sources.

NATO production prime contract (-0053) with Boeing included the following language:

1. Per Special Provision clause J.8(c) of the -0053 prime contract, all data and software provided to the US Government under -0218 may be

provided to the NATO AEW&C Programme Management Organization (NAPMO) by the USG, subject to the rights and restrictions of -0218.

2. Per Special Provisions clause J.8(a), data and software necessary for operation and maintenance of the NATO E-3's will be delivered to NAPMO in accordance with the CDRL.
3. NAPMO means NAPMO and the participating governments.
4. Per Special Provisions 8(d), contractor agrees to make available on fair and reasonable terms to NAPMO any technical information not otherwise subject to delivery under the -0053 contract together with the right to use or have used this technical information to the extent required for the operation, support, and modification of the NATO AEW&C Program.

Annual DLM work to be contracted to European industry was originally thought to be approximately \$10 million (1977 dollars), but by the mid 80's it appeared that it would be considerably less.

NATO was planning on investing around \$40 million in tooling, test equipment and training to establish a European capability. Another \$20 million in support and test equipment was thought to be available from NATO production programs.

The NATO AEW Force Command will have control over configuration, i.e., whether or not changes or mods are incorporated. The relationship between the NATO Force Command and U.S. AFLC in implementing this authority was uncertain as of that time.

One of the biggest surprises for DRW in the initial phase of DLM planning was that in the U.S., it was the USAF that assumed system management responsibilities, not the prime contractor. Though the AFLC has system management responsibilities, they do continue to rely heavily on OEMs organic engineering design capabilities. An OEM usually maintains the historical technical file, but AFLC exercises its prerogatives by continuing to complete work.

For the NATO DLM program some uncertainty existed as to the OEMs configuration management functions vis a-vis the SOR's. For Boeing, in addition to its configuration management functions, the company was on line to NAPMO to provide engineering services in support of its DLM proposal effort. Boeing did however, stay out of the evaluation process.

Diminishing resources (i.e., lower rate or completion of production in the U.S.) will impact availability of OEM technical support. The issue of obtaining relief from U.S. Government asset use charges for OEM maintenance, overhaul and repair work for the NATO fleet needed to be raised with the U.S. Air Force.

The NATO DLM program was to inherit a significant amount of support and test equipment from the production program. NAPMO's DLM solution did not originally include partial substitution by automatic test equipment (ATE) or power supply test sets (PSTS) but Dornier is now taking a look at these alternatives.

As of late 1983 AEG-Telefunken and Westinghouse were the most advanced of SOR-OEM efforts, as they had been building upon pre-existing production relationship. SEL and Siemens currently are not bidding for DLM work. Sabena (the Belgian national airlines), for its part, required virtually no additional OEM support due to its allotted tasks being air vehicle related, in line with existing capabilities with commercial 707-320C's.

The possibility of OEMs coordinating on a model set of general provisions as a point of departure was discussed at the fall 1983 meeting in Seattle. However, these would naturally vary in line with individual OEM preferences and whatever can be ultimately negotiated with the individual European SORs.

Several points of consensus that came out at the fall 1983 OEM meeting in Seattle follow:

- The ultimate SORs needed to be identified as soon as possible.

- Export authorization for NATO DLM required additional approvals and followed the same channels as the production program - the E-3A Foreign Disclosure Policy Officer (FDPO) in Seattle continued to be the U.S.

- Government focal point for submittal and clearance for technical data and hardware export, prior to forwarding to the State Department's Office of Munitions Control. OEMs submitted requests to the FDPO for the E-3 program, for approval of industry-to-industry Maintenance License Agreements (usually of ten year duration) and applications for the biennial hardware export licenses.

NAPMA and ESD have recently begun to accelerate their efforts to match future support equipment (e.g., tooling and test equipment) needs against available assets and generate the hard requirements to allow the excess hardware screening/work order transfer process to proceed in line with their plans.

OEMs are supporting SOR proposal preparation, charging only if the effort is of significant magnitude. Given the lack of project definition and funding, OEM effort could be significant and expensive if detailed estimating and planning were provided, whereas ROM/outline data appears to be sufficient at this stage.

The SORs have encountered difficulties interpreting requirements for which they are bidding. In the meantime, their appetite for data must be kept in line with their need/capability to pay for it. The Italian segment of DLM effort involved the greatest departure from pre-existing experience with the specific hardware to be maintained, and consequently, the potential for lack of definition and duplication of OEM, as well as SOR, effort.

The OEMs should be attentive, as the U.S. progressively converts to ATE and PSTS, to the possibility of surplus FSE/STE being offered to the NATO Main Operating Base (MOB) and SORs. To a lesser extent the same would apply to surplus tooling and test equipment resulting from the lower rate of production that will exist in the foreseeable future.

Fees (initial and/or annual) associated with the cost of setting up maintenance license agreement (for training, hardware procurement and technical support along with certification/capability reports) would probably be charged. For effort that cannot be adequately defined for fixed fee pricing, level of effort rates will be offered.

#### D. NATO E-3 Enhancements

Then there was the issue of the enhanced capabilities for the AWACS that had to be postponed back in 1978 when the program was launched, due to cost pressures. These include an Software Support and Test Facility (SSTF), ESM, ECM, and several other items. The validity of these military requirements reportedly continued to be recognized, while it began to appear by 1983 that the initial enhancement of the system could be accomplished through program savings, not through additional contributions from the participating NATO governments. As E-3 production costs improved, in May 1984, a Wehrdienst article on the NATO AWACS program announced that NAPMA would be hanging on to its excess funds resulting from the AWACS under-run, not returning them to the contributing nations.

However, in addition to the improvements mentioned above, the money was needed for a reserve fund to cover for contingencies. In particular there were the risks associated with the integration of the AWACS and the NADGE system for which Hughes is the prime contractor.

The planned use of these excess funds did not become an issue until the end of the year however, when the scope of the under-run became apparent. An article by Peter Blechschmidt in the January 3, 1985, issue of the German weekly

magazine Stern, entitled "NATO Procurement of Weapon System Using Imputed Interest" described how, with 'millions in funds and a favorable investment of money, NATO wanted to by-pass the national parliaments in buying new equipment'. Below is a rough translation of the article.

"This is a proceeding that I can only classify as fraud," stormed Christian Democratic Party (CDU) defense expert, Willy Wimmer. He was reportedly bitter over the financial tricks he had uncovered at the MOD in Bonn. There Wimmer had found out how the military has been able to obtain an upgrade of the AWACS AEW system through the back door, one that the Bundestag had rejected as too expensive.

The caption under the photo of the politician stated: "We won't let that happen to us". The CDU Defense expert Willy Wimmer has found out that the NATO authority, NAPMA, wants to outfit the AWACS AEW system with new equipment which the national parliaments had previously turned down.

The 'trick' goes like this: the procurement and stationing of the flying radar centers stretch out over 10 years. During this time, the NATO authority established for the procurement of the AWACS, NAPMA, was able to accumulate substantial interest in its own account. The deposits of the twelve partner countries were made according to a previously laid down payment schedule, and were not immediately passed on to the manufacturers.

The money sitting in the account accumulated interest and grew by the end of 1984 to a windfall of about 167 million dollars (or around 500 million marks). That was almost 10 percent of the originally agreed to total program cost of 1.8 billion dollars, for which the Federal Republic agreed to about a 30% contribution.

With this windfall the NATO leadership now wanted to finance additional ESM and ECM devices that had been rejected by the national parliaments in their budgets at the beginning of the AWACS program in 1978. Colonel Edward von Kospoth, who was responsible for the AWACS system at the MOD, attributed these belated procurements to clever management: "If we can finance the upgrades without additional burdens to the national budgets, that's good for all concerned."

The idea of utilizing the windfall resulting from the under-run, to reduce the national contributions, has also occurred to the various MOD's, but was quickly rejected. The NATO Partners showed no interest. Moreover, argues von Kospoth, once the windfall has been distributed, the money's gone. The up-grades will be done eventually anyway, only later it will be that much more expensive.

Willy Wimmer, has trouble with this line of reasoning. He criticized, in addition, the fact that the MOD had informed only the Budget Committee

and not the Defense Committee; this despite the fact that each defense improvement program needed the consent of the defense committee.

On the matter of the windfall resulting from the obsolete payment schedule, the Bundestag reps felt they were taken in. In the last MOD report of June 1984, the expected imputed interest for the entire life of the program had been reported to be 88 million dollars. But in actuality by the end of the year, the figure was almost twice as high.

Such practices, Wimmer, went on to tell Stern, do not contribute to the trust that the Bundestag deputies place in the credibility and seriousness of the MOD planners. "This has nothing to do with government versus opposition. We just can't let this happen."

Moreover, the resolute parliamentarians saw confirmed in the AWACS windfall, their heldlong suspicions of what was referred to as the MOD's sloppy planning. For example, the MRCA Tornado fighter had an excess of around 1.2 billion marks which they felt should be given back to the Finance Minister. With more exact calculations, they could make do with much less in the way of appropriations.

Shortcomings in planning for NATO projects is a particularly sensitive subject for Wimmer's colleagues. These projects are often overestimated. The remaining funds could go then for other projects or be paid back. "Substantiating doubts in acts of expediency, on NATO programs, tend to undermine a basically positive attitude toward the NATO partners and must be quickly removed," Wimmer declared in a letter to Worner.

The minister had yet to respond at the time the article appeared in Stern. Several months later German sources reported the issue over appropriations had died down and NAPMO was proceeding with its planned enhancements.



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